

Project AIR FORCE

2001 Annual Report

Director's Message

The research findings highlighted in this year's Project AIR FORCE (PAF) annual report represent the broad spectrum of work the Air Force has asked us to undertake.

Our mission is to conduct an integrated program of objective, independent analysis on issues of enduring concern to Air Force leaders. PAF addresses far-reaching and interrelated questions: What will be the role of air and space power in the future security environment? How should the force be modernized to meet changing operational demands? What should be the size and characteristics of the USAF workforce, and how can that workforce be most effectively recruited, trained, and retained? How should sustainment, acquisition, and infrastructure be streamlined to control costs?

PAF conducts research in four programs that represent core competencies:

Strategy and Doctrine seeks to increase knowledge and understanding of geopolitical and other problems in the national security environment that affect Air Force operations. PAF maintains expertise in defense strategy; regional analysis; the objectives and tasks of evolving joint operations; and the potential contributions of air and space power to joint operations, defense planning, and requirements for force development.

Aerospace Force Development identifies and assesses ways in which technological advances and new operational concepts can improve the Air Force's ability to satisfy a range of future operational demands. This research involves assessments of technology feasibility, performance, cost, and risk. PAF assesses major force components needed in the future and the systems and infrastructure supporting their operations.

Manpower, Personnel, and Training concentrates on questions about workforce size and composition and about the best ways to recruit, train, pay, promote, and retain personnel. PAF's research encompasses the total workforce: active duty, guard, reserve, civilian, and contractor personnel.

Resource Management analyzes policies and practices in logistics and readiness; outsourcing, privatization, and contracting; the industrial base; planning, programming, and budgeting; infrastructure; and weapon-system cost estimating.

The goal of this program is to maximize the efficiency and effectiveness of Air Force operations in a resource-constrained environment.

PAF also conducts wide-ranging research on topics that cut across all four programs, and we regularly respond to Air Force requests for help on time-urgent problems.

The research described in this annual report is broad ranging:

- We provide an historical perspective on operations conducted against enemy leaders, and we offer an analysis of why Milosevic decided to settle the conflict over Kosovo when he did. We discuss the activities carried out by special operations forces against elusive ground targets during the Vietnam and the Persian Gulf wars as well as current efforts to detect and destroy such targets. Each of these reports has direct applicability to Operation Enduring Freedom today.
- We report on NATO enlargement that could occur in a 2000–2015 time frame and its implications for defense planning. We also extract lessons for future coalition operations that emerged from Operation Allied Force in general and from NATO's air war over Kosovo in particular.
- In the context of the 2001 Quadrennial Defense Review, we describe the results of a comparison of the three prior defense reviews—the Base Force analysis, the Bottom-Up Review, and the 1997 Quadrennial Defense Review.
- The analysis we conducted for Air Combat Command of the links among infrastructure, mission and training requirements, and available airspace and ranges lays the foundation for continuing assessments of important training needs as USAF combat forces evolve and change.
- Ongoing research on support concepts for the Expeditionary Aerospace Force resulted in several reports, two of which are included here: intermediate maintenance of F-15 avionics and support for LANTIRN.
- In the area of acquisition, we assessed the credibility of cost-savings claims resulting from acquisition reform and from lean manufacturing in the defense sector. We developed new processes for estimating military airframe costs, and we devised a framework for cutting costs while supporting small businesses by using bundled services.
- Our research on Latin America remains important. Included in this report is an account of the relationship between drug trafficking and insurgent activity in Colombia.

- We conclude with an overview of our ongoing work on Asia by discussing a new U.S. strategy for a changing Asia, the implications of China's commercial technology for future military capabilities, India's emerging nuclear posture, and the importance of Indonesia's future to regional stability.

In addition to reflecting the comprehensiveness and depth of PAF capabilities, some of this work now seems prescient. We were concluding work on our FY2001 research agenda and were expecting approval of the FY2002 research plan jointly developed with our Air Force Steering Group when the nation was stunned by the tragic events of September 11. The entire Department of Defense was called into immediate action, and the Air Force hastened to develop a coherent and effective response to the terrorism being directed against our homeland on a previously unimagined scale.

RAND and PAF were able to offer relevant reports, as well as the expertise of highly qualified staff members who had conducted long-term studies of terrorism and counterterrorism. We were also able to work with the Air Force leadership to quickly reshape PAF's FY2002 agenda, which now includes research on homeland security and defense, strategies for countering global terrorism, and analyses of the long-term effects of this new form of conflict on the active-reserve force mix.

This flexibility reflects the trust that the Air Force places in PAF as a result of our 56-year partnership. And it is the Air Force's vision and continuing demonstration of confidence that enables us to contribute our collective energies and expertise to the safety and well-being of this nation.



Natalie W. Crawford

Director, Project AIR FORCE

Contents

Director's Message	iii
Research Highlights	
Operations Against Enemy Leaders	1
Why Milosevic Decided to Settle the Conflict Over Kosovo When He Did	5
Special Operations Forces and Elusive Ground Targets: Lessons from Vietnam and the Persian Gulf War	10
Meeting the Challenge of Elusive Ground Targets	14
NATO Enlargement 2000–2015: Implications for Defense Planning	19
Operation Allied Force: Lessons for Future Coalition Operations	25
NATO's Air War for Kosovo: A Strategic and Operational Assessment	31
Balancing Strategy, Forces, and Resources: Lessons for the Current Defense Review	36
Airspace and Ranges: Linking Infrastructure Needs to Mission and Training Requirements	43
F-15 Avionics Intermediate Maintenance Options for Expeditionary Aerospace Force Support	47
Supporting LANTIRN in the Expeditionary Aerospace Force	54
Acquisition Reform and the Defense Sector: An Assessment of Cost-Savings Claims	59
Lean Manufacturing and the Defense Industry: Lessons for Cost Analysts	62
New Processes for the Estimation of Military Airframe Costs	67
Bundled Services: A Framework for Cutting Costs, Improving Performance, and Supporting Small Businesses	70
Drugs and Insurgents in Colombia: A Regional Conundrum	75

A New U.S. Strategy for a Changing Asia	78
China's Commercial Technology:	
Implications for Future Military Capabilities	81
India's Emerging Nuclear Posture	85
Indonesia's Future: Challenges and Implications for Regional Stability	92

Publications

Fiscal Year 2001 Publications with Abstracts	97
--	----

Administration

USAF Project AIR FORCE Steering Group	113
Project AIR FORCE Management	113
Project AIR FORCE Program Directors	114
Air Force Fellows at RAND	114
RAND Organization	115
Corporate Officers	115
Research Units	115
Education Unit	116
Board of Trustees	117

Operations Against Enemy Leaders

Operations that threaten the person and power of senior enemy decisionmakers have long been considered to be promising instruments for shortening wars, affecting other changes in enemy policy and behavior, and degrading enemy warfighting capability. Over the years, the United States has mounted both overt and covert operations to kill enemy leaders directly or to secure their overthrow either by indigenous coup or rebellion or by external invasion and takedown. RAND research analyzed some two dozen cases of attacks on leadership from World War II to the present. Policy and operational lessons were derived regarding the comparative efficacy and prerequisites for success of different forms of attack, their potential coercive and deterrent value, and the possible unintended consequences of their ill-considered use.

Direct Attacks, Coups, and Rebellions Have Poor Results

Because enemy leaders devote priority attention and large resources to the protection of their persons and power, they are hard to kill and overthrow. With the single exception of the shootdown of Japanese Admiral Isoroku Yamamoto's aircraft in World War II, all U.S. efforts to directly attack senior enemy leaders—from Fidel Castro to Muammar al-Qaddafi to Saddam Hussein to Slobodan Milosevic—have failed. Direct attacks typically do not succeed because the targeted leaders are protected by elaborate security measures that deny the attackers access to their persons and timely intelligence about their locations. These leaders tend to move frequently, and when threatened they often relocate to "safe houses" in civilian residential areas or to hardened facilities. Self-imposed humanitarian, political, and legal constraints also limit the means by which enemy leaders can be attacked.

The only coups d'état explicitly sponsored or sanctioned by the United States that have succeeded have been against leaders who had lost the support of significant elements of their own military—Mohammed Mossadeq in Iran and Ngo Dinh Diem in South Vietnam. The one successful ouster of a leader through a rebellion organized by the United States—Jacobo Arbenz in Guatemala—was accomplished by limited air attacks and ground force demonstrations against a government that was again denied backing from its own armed forces. Coups and attempted rebellions have failed when the targeted leaders—such as Qaddafi, Manuel Noriega, and Saddam—have been protected by ubiquitous

intelligence and internal security services, large praetorian guard forces, or other loyalist units.

Even Successful Attacks Often Do Not Produce Desired Results

While the capture and subsequent apostasy of charismatic guerrilla leaders—such as Abimael Guzman in Peru—have seriously weakened some antigovernment rebellions, the demise, capture, or incapacitation of an enemy leader typically does not result in a favorable change in enemy policy or behavior. The frequent futility of leadership attacks is borne out by the Israeli attempts to suppress Palestinian terrorism and by the Russian attempts to pacify Chechnya. Indeed, previous analyses of the effects of political assassinations from antiquity through modern times document the infrequency with which the killing of a particular leader has produced the results the assassin hoped for.

Experience also shows that ill-considered leadership attacks can produce extremely harmful unintended consequences. The U.S. helicopter gunship attack on Somali National Alliance leaders in Mogadishu on July 12, 1993, proved to be a major blunder because it dramatically increased support for General Aideed and generated such strong anti-American sentiments that Somalis were thereafter motivated to kill U.S. troops.

Because such attacks on enemy leadership can be counterproductive, U.S. leaders must be confident that their benefits will outweigh possible costs. To make such assessments, U.S. officials should consult knowledgeable area experts to determine the likely reactions of enemy and other publics to a successful leadership attack, its possible effects on power relationships within the enemy camp, and how it is likely to affect the enemy policy and behavior that the United States wishes to modify.

Coercive Effects of Attacks Have Been Uneven

The prospect that the United States might attack a leader directly or attempt to foment his overthrow by a coup d'état seems to have had little deterrent or coercive effect. Enemy leaders, including Castro, Qaddafi, and Saddam, all continued to pursue policies harmful to U.S. interests after being targeted by such U.S. operations. Among the possible reasons for this defiant behavior may be the enemy leaders' belief that their enhanced security measures will allow them to survive any future U.S. attacks, their fear that acquiescence to U.S. demands

might undermine their credibility and authority among the key constituencies that maintain them in power, or their willingness to die for their cause.

However, there also have been instances when enemy leaders have preferred to yield rather than risk intensified U.S. air attacks that could spark sufficient domestic discontent to produce their ouster. Such was the case with Milosevic during the conflict over Kosovo. In some instances, the United States has also been able to create coercive leverage by supporting indigenous rebellions. The U.S. arms and logistical support to rebel and resistance movements in Angola, Nicaragua, and Afghanistan produced useful bargaining leverage for the United States in those Cold War conflict situations.

Air Power Can Sometimes Be Used in Attacks on Leadership

The historical record suggests that U.S. decisionmakers will be willing to sanction direct attacks against enemy leaders if they can be

- justified by the right of self-defense
- said to be directed against facilities that serve a military or security function
- conducted by uniformed members of the armed services in accordance with the law of armed conflict
- embedded in a larger military campaign.

Decisionmakers will be most willing to sanction such attacks when they believe the targeted leader is the key promoter or facilitator of the policy and behavior that the United States wishes to change.

Because enemy leaders frequently change locations and resort to deception and camouflage to mask their whereabouts, the success of any air attack will depend heavily on the availability of accurate, near-real-time or predictive intelligence. Special penetrating weapons will be required to effectively attack command bunkers located deep underground, and accurate, low-yield munitions will be needed to strike leaders who relocate to civilian residential areas.

If circumstances permit, the intervention of U.S. air power could enhance the prospects of a coup or rebellion that might otherwise fail because the antiregime forces lacked the firepower and other combat capabilities to prevail. Providing effective air support to a coup would likely pose difficult operational problems, in that the outcomes of most coups are decided within hours rather than days. Washington decisionmakers would have to be prepared to commit forces

promptly, and U.S. air elements would have to be poised for immediate action. Providing combat support to a rebellion, while operationally less taxing, could prove difficult to sustain politically given that it might take years for an opposition group to gather sufficient strength to overthrow an entrenched government.

External Takedowns Remain the Most Certain Way to Remove Enemy Leaders

The surest way to unseat a hostile regime is to oust it with external military force. Since the takedown of the Axis powers in World War II, the United States has employed its armed forces to remove hostile regimes in Grenada and Panama and to force the abdication of a ruling military junta in Haiti. The decision to order these takedowns was undoubtedly made easier by the fact that all three of the targeted governments possessed extremely weak military forces.

Generally, U.S. decisionmakers will be reluctant to sanction the invasion and occupation of enemy states because of the likely costs involved. However, there may be contingencies—such as an attack with weapons of mass destruction on the U.S. homeland—that would impel U.S. decisionmakers to even order the takedown of an enemy state that possessed large and well-equipped military forces. For some enemy leaders, the threat of overthrow and punishment by external military force may have a greater deterrent and coercive effect than the threat of death or removal by other means. To persuade adversaries that it has the political will and military capability to conduct such takedowns, the United States will need to maintain robust air, ground, and naval forces capable of expeditionary operations. Indeed, the potential need for takedowns should be included among the major contingencies for which U.S. forces are sized.

MR-1385-AF, *Operations Against Enemy Leaders*, Stephen T. Hosmer

Why Milosevic Decided to Settle the Conflict Over Kosovo When He Did

The Kosovo conflict was essentially settled on June 3, 1999, when Slobodan Milosevic, then-president of the Federal Republic of Yugoslavia, decided to accept NATO's terms for ending its 78-day bombing campaign. Since U.S. leaders will undoubtedly seek to apply the lessons of Kosovo to future conflicts, it is important that the motivations and calculations underlying Milosevic's decision be understood. Two questions in particular require resolution. First, why did Milosevic refuse to settle the conflict earlier—say after a few days of bombing—as many allied leaders initially expected he would? Second, why didn't he attempt to hold out even longer, as most NATO leaders eventually feared he would?

RAND research drew upon the testimony of Milosevic and other Serb and foreign officials who directly interacted with the Yugoslav president to weigh and analyze the various factors and pressures that appear to have most heavily shaped Milosevic's decisionmaking. The research results offer insights into the capabilities that the United States and its allies will need for future coercive operations.

Why Milosevic Didn't Settle Early On

One likely reason Milosevic did not capitulate immediately was that he thought it dangerous to do so. The proximate cause for the 78-day bombing campaign that began on March 24 was Milosevic's refusal to sign the Rambouillet Agreement. The agreement would have ended the Serb hegemony in Kosovo by severely restricting the Yugoslav military and police presence and by providing for a NATO-led force to keep the peace in the province. It also would have threatened Yugoslavia's sovereignty by giving NATO forces access rights throughout the country and by suggesting that Kosovo's future could be determined by a referendum of its residents, a vote that the Kosovo Albanians surely would have won.

Even though his governance was authoritarian, Milosevic still had to rely on elections to extend his rule. Accepting the Rambouillet Agreement without a fight or a popular consensus to do so could have endangered his continued hold on power. The Serbian people were strongly attached to Kosovo as the cradle of their ancient culture. Moreover, Milosevic's rise to power and credibility as a nationalist leader stemmed largely from his promise to promote Serb hegemony over the province.

Milosevic also refused to yield early on largely because he believed he could get better terms by holding out. He thought NATO's unity and resolve with respect to Kosovo would eventually dissolve. There were three main reasons for this belief. First, Milosevic assumed that the refugee crises stemming from the Serb ethnic cleansing in Kosovo would pressure NATO to cease its attacks by showing the bombing to be counterproductive and harmful to the welfare of the Kosovo Albanians and to the stability of Macedonia and Albania. Second, he expected that Serb civilian casualties and NATO air losses from the bombing would turn the NATO publics against the war. Finally, he assumed that Russia would steadfastly support Belgrade's position and apply pressure on NATO to terminate the bombing.

Why Milosevic Decided to Settle on June 3

These assumptions required time to test fully, but by early June Milosevic realized that none would stand up.

His hoped-for leverage on NATO had evaporated. Milosevic's decision to push some 700,000 Kosovo Albanian refugees into Macedonia and Albania turned out to be a major blunder. The horror of ethnic cleansing strengthened the resolve of the NATO governments to continue the air attacks and hardened their terms for war termination. The hope that civilian casualties and allied air losses would produce bargaining leverage for Belgrade went unrealized. The measures NATO leaders adopted to avoid the death or wounding of allies and to hold down enemy civilian casualties limited the active opposition to the war in the allied countries where important political constituencies harbored significant doubts about the NATO bombing.

Moreover, Milosevic's assumption that he could count on Russia's continued backing also proved misguided. While Russian public opinion strongly supported Serbia, Boris Yeltsin believed that a protraction or escalation of the conflict would act against Russia's economic interests in maintaining good relations with the West. NATO's steadfastness, and the increasing talk of an invasion that Yeltsin feared would prove particularly harmful to Russia's interests, eventually led Yeltsin to acquiesce to NATO's bottom-line demands.

The bombing produced a popular climate conducive to concessions. The initial popular response to the bombing had been one of patriotic defiance: The Serbian people rallied around the flag and Milosevic and supported the Belgrade government's refusal to yield on Kosovo. However, after a month or so of air attacks, the popular mood began to change: People became increasingly war weary, concerned with their daily survival, and desirous for the bombing to end.

The change in public mood was such that Milosevic could now make concessions that might have cost him his power before the air attacks began. Indeed, when the conflict ended there were no demonstrations against the peace terms, even by the radical nationalists who had vowed never to allow foreign forces to enter Kosovo.

Damage to “dual-use” infrastructure generated growing pressure within the regime for compromise. By early June, the bombing was apparently perceived to be causing a magnitude of damage to Serbia’s infrastructure and economy that, if allowed to continue, could eventually threaten the regime’s survival. In addition, the air attacks were creating stress, hardships, and costs for members of the ruling elite. Most of this pressure resulted from NATO attacks on six types of fixed infrastructure targets located mainly in Serbia: command, control, and communications; leadership; lines of communication; electric power; industrial plants; and petroleum, oil, and lubricants facilities. The vast majority of these targets were of the “dual-use” variety in that they served a civilian as well as a military function.

Damage to Yugoslav military forces and the “resurgence” of the Kosovo Liberation Army generated pressure. Even though purely military targets were the primary focus of the NATO air campaign, air attacks on such targets did not greatly concern Milosevic. Most of the purely military facilities struck by NATO were empty of personnel and equipment when hit, and the amount of Yugoslav army armor and artillery lost to NATO air attacks constituted only a small percentage of total inventories. Nor is there evidence that the purported “resurgence” of the Kosovo Liberation Army (KLA) in Kosovo significantly affected Milosevic’s decision to yield. Even at the end of the conflict, Yugoslav military and security forces continued to dominate the battlefield in Kosovo.

Milosevic expected unconstrained bombing if NATO’s terms were rejected. The evidence suggests that the principal reason Milosevic accepted NATO’s terms on June 3 was his fear of the bombing that would follow if he refused. Milosevic and his colleagues believed that NATO was poised to launch a “fierce” and unconstrained bombing campaign if its peace terms—which had now been endorsed by Russia—were rejected. The Serb leaders were convinced that NATO was prepared to employ “massive bombing” to demolish their country’s entire infrastructure—including its remaining bridges, electric power facilities, telephone systems, and factories. Milosevic apparently calculated that the Serbian public would neither long tolerate nor forgive him for the hardships that would result from such intensified bombing, particularly if its more extreme effects—such as a continuous, nationwide power outage—carried over into the harsh Balkan winter. He therefore concluded that a continued refusal to make peace would likely cost him his hold on power.

He probably also worried about the threat of future invasion. The increasing talk of an eventual NATO ground invasion was probably another, though lesser, factor in Milosevic's decision. While Milosevic had reason to view an invasion as a more distant threat—it would have taken NATO two to three months to deploy sufficient troops within the theater for a ground attack—he may have worried that a future ground conflict might not be confined to Kosovo and could directly endanger his power, safety, and freedom.

Milosevic believed NATO's terms were the best he could get. Finally, Milosevic acceded to NATO's demands because he was convinced that NATO's terms were unlikely to improve and realized that the agreement being offered provided him with some political cover. While certain terms, such as the requirements governing the withdrawal of Yugoslav forces from Kosovo, were less favorable than those contained in the Rambouillet Agreement, other terms could be portrayed as improvements. NATO's access was now limited only to Kosovo; there was no longer a suggestion that Kosovo's future would be decided by a referendum; and Yugoslavia's territorial integrity and sovereignty with respect to Kosovo were reaffirmed by the Security Council. Thus, even though NATO's basic demands were satisfied, Milosevic could still claim a victory of sorts.

U.S. Forces Need the Capabilities and Freedom of Action to Coerce Future Adversaries

Drawing upon the lessons of the Kosovo experience, the author makes two recommendations relating to the coercive use of air power in future conflicts.

Improve capabilities to locate, identify, and rapidly strike enemy mobile targets. NATO's attempts to "systematically" and "progressively" destroy Yugoslav military forces and thereby pressure Milosevic to come to terms proved largely unsuccessful. The Yugoslavs were able to preserve intact the vast bulk of their ground forces by dispersing them before the bombing began and by making extensive use of concealment, civilian shielding, and hardened underground shelters. To better counter such tactics in future conflicts, the United States and its allies must seek to develop sensors, surveillance and reconnaissance platforms, target processing and dynamic control measures, weapon systems, and concepts of operation that will improve their ability to attack enemy armor and artillery forces when such forces are widely dispersed, hidden under foliage, or located in civilian settings. To minimize civilian casualties, extremely accurate low-yield munitions will be required to attack enemy military forces located in or near civilian structures. Special munitions will also be required to effectively

attack enemy leadership and command, control, and communication facilities that are located deep underground.

Preserve the option to attack dual-use targets. In the Kosovo conflict, it was the attacks and threat of additional attacks on dual-use infrastructure targets that generated the decisive pressure for war termination. In future conflicts, such attacks may be the most effective—and in some instances, the only feasible—way to coerce enemy decisionmakers to accept U.S. peace terms. However, attacks on dual-use targets may carry a particular risk of legal sanction in that the military utility and therefore the legitimacy of a given target can differ with the eye of the beholder. American decisionmakers and military personnel may be reluctant to order or conduct attacks on dual-use targets if they believe such action could expose them to prosecution as “war criminals.” Therefore, the United States must not assume binding obligations that could subject U.S. personnel to possible prosecution and conviction by an international court for directing or conducting attacks on targets that responsible U.S. legal authorities had certified to be legitimate military targets. But to comply with laws of war and to retain the political support needed to sustain military interventions, the United States and allied forces will also need to maximize their capability to attack such dual-use targets with minimal loss of civilian life and other unintended damage.

MR-1351-AF, *The Conflict Over Kosovo: Why Milosevic Decided to Settle When He Did*, Stephen T. Hosmer

Special Operations Forces and Elusive Enemy Ground Targets: Lessons from Vietnam and the Persian Gulf War

During both the Vietnam War and the Persian Gulf conflict, U.S. political and military leaders confronted strategically important but elusive ground targets. Political and other considerations prevented the deployment of conventional ground units, and air power alone proved unable to eliminate the targets. In both cases, policymakers turned to special operations forces (SOF) to conduct reconnaissance operations to locate the hidden targets. During the Vietnam conflict, SOF teams crossed the border into Laos to search for truck parks, storage depots, and other critical targets along the Ho Chi Minh Trail that were obscured by triple-canopy jungle and camouflage. During the Gulf War, British and American SOF patrolled vast areas of western Iraq searching for mobile Scud launchers that had escaped coalition strike aircraft.

In both cases, the SOF ground teams were less successful than U.S. officials had hoped. This study examined those conflicts to shed light on how SOF ground teams might be more effectively employed in the future.

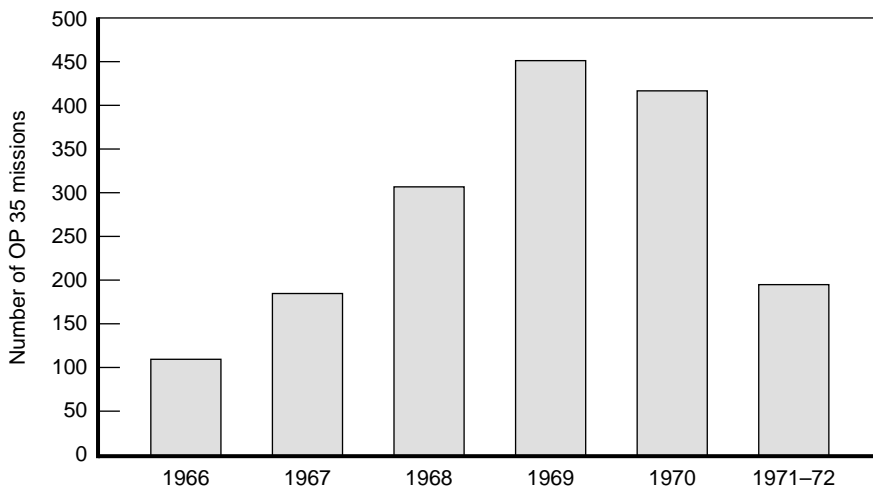
Despite SOF Efforts, Traffic on the Ho Chi Minh Trail Continued Throughout the War

During the mid-1960s, U.S. military and political leaders faced a critical challenge as they embarked on what was to become a protracted ground war in Southeast Asia. Since 1959, the military forces of the Democratic Republic of Vietnam had used the Ho Chi Minh Trail to infiltrate vast quantities of men and materiel through Laos into the U.S.-backed Republic of Vietnam. This network of footpaths, trails, and roads ultimately came to serve not only as a supply line for North Vietnamese forces but also as a basing area from which attacks could be staged on South Vietnam.

U.S. forces confronted formidable obstacles in their efforts to stem the flow of traffic along the trail. For example, under the terms of the 1962 Geneva Accords, neither the United States nor North Vietnam was permitted to conduct ground operations within Laos. Hanoi ignored this provision outright, but the United States honored it by ruling out the use of ground troops in the area. Further limit-

ing U.S. options was the Ho Chi Minh Trail itself, whose unremitting terrain, obscured by triple-canopy jungle, severely compromised the effectiveness of U.S. air attacks.

To boost the ability of U.S. aircraft to engage targets along the Ho Chi Minh Trail, OP 35—a special operations unit of the Military Assistance Command, Vietnam, Studies and Observation Group (MACVSOG)—conducted hundreds of cross-border missions in Laos. The figure below shows the number of OP 35 missions per year from the first missions in 1966 to 1972, the year MACVSOG was closed down. OP 35 ground teams not only identified targets and called in air strikes but also undertook direct-action missions, battle damage assessment, and the emplanting of mines and sensors.



SOURCES: Richard Shultz, *The Secret War Against Hanoi*, Chapter 6; Harve Saal, *SOG: MACV Studies and Observations Group*, Vol. 3, *Legends*, p.186.

From 1966 to 1972, OP 35 Conducted Hundreds of Cross-Border Operations in Laos

From its inception, however, OP 35 faced significant barriers. In addition to obscuring visibility from the air, the dense jungle hindered movement on the ground. The sheer length of the trail (12,000 miles) was daunting. The time between the SOF's identification of a target and the delivery of ordnance was approximately 30 to 40 minutes, which gave the enemy time to detect the presence of OP 35 personnel. The People's Army of Vietnam (PAVN) employed a number of effective camouflage, deception, and patrol techniques. Hanoi also devoted substantial intelligence resources to the penetration of MACVSOG, including the use

of barmaids, drivers, and other local personnel as spies. As a result of these measures, OP 35 casualty rates rapidly mounted. In 1969, the peak year of OP 35 activity, the casualty rate per mission was a staggering 50 percent. Even at this cost, however, OP 35's cross-border operations never seriously impeded enemy traffic across the Ho Chi Minh Trail.

In the Persian Gulf War, Mobile Scud Launchers Eluded American and British SOF

Two decades after the end of the Vietnam War, the United States and its Arab and non-Arab coalition partners faced a determined foe in the Persian Gulf. In January 1991, Saddam Hussein succeeded in deploying Scud missiles aboard mobile launchers and initiated attacks on Israel. Although they inflicted little damage, the Scud attacks threatened to draw Israel into the ongoing Persian Gulf conflict. Any Israeli military action would have destroyed the fragile Arab coalition that had been forged against Iraq. To help persuade Israel not to take action, the coalition undertook a vigorous air campaign to destroy Iraq's Scud launchers.

However, Iraq's mobile transporter-erector-launchers (TELs) proved highly elusive to aerial reconnaissance. To thwart aerial detection, the Iraqi military used high-fidelity decoys and took full advantage of gullies, culverts, and underpasses in the vast expanse of Iraq's 29,000-square-mile desert. In response, U.S. and British SOF were deployed to enhance the effectiveness of air strikes by searching for Scud launchers on the ground.

In the immediate aftermath of the Gulf War, coalition leaders announced that their efforts had neutralized the Iraqi Scud threat. Within months, however, postwar reports on Gulf air operations began to cast doubt on these claims. According to a Pentagon study, few mobile TELs had been eliminated. On a tactical and operational level, the coalition's SOF effort in Iraq neither eliminated nor seriously hampered the Scud threat.

SOF Achieved Strategic Successes

Special operations efforts in Southeast Asia and Iraq proved less than decisive. However, these campaigns were not failures. In Southeast Asia, SOF operating along the Ho Chi Minh Trail harassed the PAVN, gathered intelligence on the enemy and, most importantly, successfully compelled Hanoi to divert resources that would otherwise have been directed to military operations against South

Vietnam. In the Persian Gulf, the 1991 Scud-hunting campaign, while destroying only a few of the mobile TELs, ultimately dissuaded Israel from entering the Gulf War—thereby meeting its key strategic objective of preserving the fragile Arab coalition against Iraq.

Specific Objectives in a Limited Area Would Maximize SOF Effectiveness

The campaigns against the Ho Chi Minh Trail and the mobile Scud launchers have a number of implications for future U.S. military operations. They highlight the difficulty of using a small number of SOF personnel to locate mobile, well-camouflaged targets in vast areas of hostile terrain. Although new technology, such as mini- and micro-unmanned aerial vehicles, may make it easier for teams to conduct wide-area reconnaissance, it is unlikely that using SOF in this way will achieve U.S. objectives. In addition, popular and official concerns about casualties and prisoners of war are likely to limit the use of U.S. SOF to those situations in which only the most vital national interests are at stake.

However, there are a number of possible ways in which SOF could be used to improve the U.S. military's ability to find and destroy elusive enemy ground targets. Unattended ground sensors could play an increasingly important role in future operations. Although most will be delivered by air, some of these sensors will require hand emplacement in difficult enemy terrain, a mission well suited to SOF. In addition, SOF can be used to assess battle damage, thus helping to ensure that critical targets have been destroyed. Finally, SOF could be employed to disable, destroy, or recover nuclear, biological, or chemical weapons, tasks that may be difficult or impossible to achieve with air power alone.

MR-1408-AE, *Special Operations Forces and Elusive Enemy Ground Targets: Lessons from Vietnam and the Persian Gulf War*, William Rosenau

Meeting the Challenge of Elusive Ground Targets

Over the past several decades, U.S. aerospace forces have become increasingly skilled at detecting, recognizing, and disabling a wide range of targets, both fixed and mobile. In response to air power's growing ability to detect and defeat large ground forces in the open, the enemy is becoming increasingly elusive, operating in smaller formations and using civilian motor traffic, built-up areas, and woods to hide its activities. Recent experience in the Persian Gulf and in Kosovo has taught that these tactics are effective particularly for long-range mobile missiles and small maneuver forces.

RAND researchers explored the nature of elusive ground targets to identify concepts and technologies that could improve the USAF's capability to detect, classify, recognize, and defeat elusive targets, whether dispersed ground forces or mobile ballistic missiles. After reviewing the factors likely to inhibit the recognition of ground targets in general, the researchers used the Kosovo experience to illustrate the challenges associated with detecting small, dispersed maneuver forces from among a host of similar objects.

Using Kosovo as its template, the study outlined new concepts that might be harnessed to defeat such forces in future operations. For the problem of countering mobile ballistic missiles in the context of a larger-scale conflict involving a more capable adversary such as China, an integrated system of technologies, focused analysis, and streamlined control procedures can enable the detect-classify-recognize-defeat cycle to occur in minutes rather than hours or days.

The War Over Kosovo: Elusive Ground Forces in Action

Perhaps more than any other recent conflict, NATO's air war over Kosovo—designated Operation Allied Force—may offer a window into the manner in which enemy maneuver forces might continue to thwart detection in future peacekeeping operations. Both before and during this conflict, Serb forces—operating in small groups under cover of nightfall—entered villages in the province of Kosovo with the singular goal of driving ethnic Albanians from their homes. Having done so, the Serbs then dispersed, hiding in woods or intermingling with civilian populations. The result was a fleeting and highly elusive foe that, even when detected, proved difficult to attack without risking damage to civilians.

Operation Allied Force was also hindered by the manifold restrictions imposed on NATO throughout the course of the conflict. The goal of NATO's air war over Kosovo was to put an end to the persecution of ethnic Albanians. Because its motive was to stop suffering rather than inflict it, Operation Allied Force was subject to exceptionally stringent rules of engagement. As a result, the allies were forced to wage a highly constrained air campaign that favored attacks on Serbia's ground troops over the more aggressive pursuit of infrastructure targets.

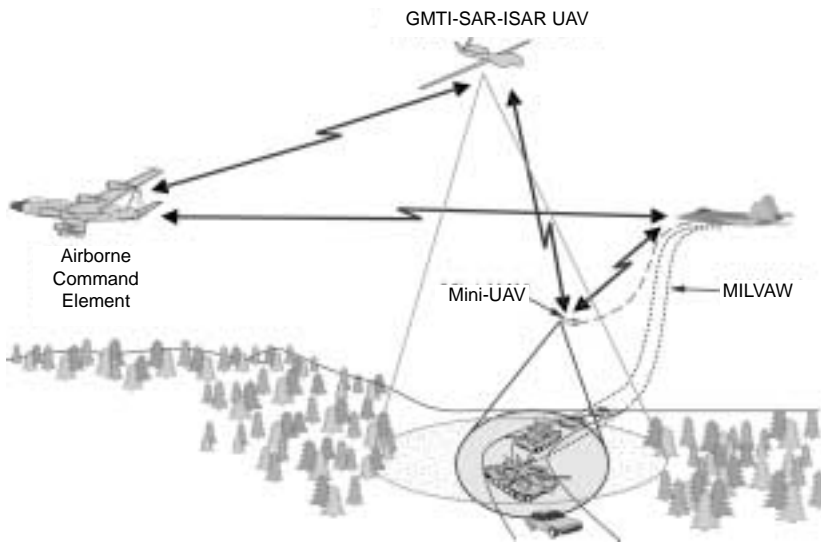
The Lessons of Kosovo: Detecting Elusive Maneuver Forces

The Challenges. Although the allies ultimately prevailed in Kosovo, the impediments they faced may well serve as object lessons for future operations. Perhaps the most pertinent of these lessons is that enemy maneuver forces may continue to elude detection even in the absence of political and operational constraints. Current wide-area surveillance radars, for example, can detect moving vehicles but have a very limited ability to distinguish military from civilian vehicles. High-resolution sensors, such as optical imagers, can distinguish tanks from trucks but have a narrow field of view and require so much human involvement that they can monitor only a small area. What is needed is a system that can monitor a large area, automatically filter out most false targets, then provide a high-resolution image of the few remaining targets to aircrews and controllers.

Proposed Technological Responses. The engagement concepts described below bring together *finders*—assets required to identify and track enemy forces, as well as civilians who might be put at risk; *controllers*—people who direct the actions of finders and strike aircraft, select worthwhile targets, and make decisions to engage; and *strike assets*—ground-to-ground or air-to-ground weapons used to attack the targets.

Two alternative approaches are proposed for locating elusive enemy forces while they are moving. In the first approach, illustrated in the figure, a high-altitude unmanned aerial vehicle (UAV) would conduct wide-area surveillance using a radar in the ground moving-target indicator (GMTI) mode. GMTI displays all vehicles moving above a predetermined speed, providing a comprehensive picture of traffic in a large area. Automatic target recognition (ATR) software on board the UAV or an airborne control post (the Airborne Command Element in the figure) would process GMTI returns to filter out signatures of nonmilitary targets. The remaining potential targets would be imaged with a synthetic aperture radar (SAR) for stationary targets or inverse synthetic aperture radar (ISAR) for moving targets. ATR software would be used to analyze these images, further reducing the number of images that controllers would have to view.

Engagement controllers on board an airborne command element would validate and correlate the remaining SAR or ISAR images with areas of suspected activity and areas of particular concern. For targets that appear valid, they would then request that a combat aircraft in the area drop a small UAV. The UAV would orbit the targets at low altitude, relaying high-resolution images to the combat aircraft and airborne command post. Together, the controllers and strike aircraft crew would assess risks and constraints and decide to engage the target. The controller would then authorize the attack, which would be carried out by a combat



UAV Views Moving Ground Targets

aircraft using a MILVAW (a Man-In-the-Loop Variable-autonomy Antiarmor Weapon), as shown in the figure. As a supplement or alternative to this approach, air-inserted, unattended ground sensors could harness a variety of detection methodologies to identify enemy military vehicles while they are traveling. Seismic sensors could detect the vibrations of such vehicles, thereby confirming that the vehicles are in motion. Acoustic sensors could then isolate the fundamental frequency and harmonics of a motorized vehicle to generate a unique acoustic signature that could be compared to a database of signatures via automatic target recognition technology.

The Need for Pre-Battle Analysis and Control. Although new technologies are necessary, they alone cannot solve this problem. Rather, it is the combination of pre-battle analysis, new technologies, and streamlined control that offers the

potential to improve U.S. capabilities against elusive targets. For these approaches to be effective, U.S. joint forces will need a better understanding of the adversary's tactics and procedures, the limitations of the adversary's equipment, and the physical and social environment. Surveillance and intelligence collection can then be focused on the most promising areas and times. For Kosovo, such pre-battle analysis would have identified those geographic features that Yugoslav forces would have to dominate to maintain control over their province, where Yugoslav forces in Kosovo would likely have deployed, and expected electronic signatures.

Defeating Mobile Missiles: A Broader Scenario. Yet another potentially elusive target set may be found in long-range mobile missiles, particularly those operating within enemy territory. During the Gulf War, mobile Scud missiles aimed at Israel and Saudi Arabia came out of hiding to level their attacks from deep within the sanctuary of the Iraqi desert. Once having done so, they continued to move to avert detection by allied aircraft. Such weapons would present an even more potent threat in the hands of a major power such as China. Operations against Chinese missile forces would be daunting because of the potentially vast areas they might hide in, the millions of civilian motor vehicles that could confuse sensors, and the advanced air defenses that the Chinese are currently developing and deploying.

To find and destroy a mobile missile launcher during the launch phase, the authors proposed a multistep process that would begin with cueing from space-based infrared satellites. Once a missile launch had been detected, the rough coordinates of the launch would be sent to a controller. The controller would then authorize a bomber or other aircraft on patrol outside Chinese airspace to launch a hypersonic weapon. This weapon, traveling at eight times the speed of sound, would fly toward the coordinates. Meanwhile, the controller would direct a space-based radar satellite to monitor the launch area with GMTI and SAR. The GMTI mode would detect any movement of the launch vehicle, and the SAR would produce images to assist in targeting. When the hypersonic weapon neared the launch area, it would go into a high-G turn to lose speed, then deploy four autonomous antiarmor weapons that would fly search patterns in the immediate vicinity. Once the launch vehicle or vehicles were found, they would be destroyed by self-forging fragment warheads.

A similar strategy could be used to detect and destroy mobile missile launchers while they are moving. In the absence of a launch signature, GMTI radars on board satellites or stealthy UAVs would constantly monitor Chinese roads, using ATR software to filter out all vehicles except those with the dimensions of missile-launching vehicles. Such vehicles would be imaged with an ISAR or SAR.

ATR software would again be used to filter out those that did not match the template. Finally, the remaining images would be sent to controllers for their evaluation. Since the rules of engagement are likely to be less strict in such a conflict, additional verification with visual-spectrum imagery would probably not be required. Rather, the controller would authorize launch of hypersonic weapons. These weapons would receive in-flight updates as the GMTI radar tracked the target. In the final phase, the target would be detected and destroyed by the autonomous antiarmor weapons as described above.

Next Steps for the United States Air Force

Although it is difficult to predict the precise role that elusive ground forces will play in future conflicts, it seems likely that such targets will become an increasingly prominent feature of the modern battleground. For aerospace forces to detect and destroy elusive forces systematically, they will need to do four things quite rapidly:

- Conduct wide-area surveillance of enemy operating areas.
- Automatically filter out a high percentage of false targets.
- Get a high-resolution picture of remaining suspected targets into the hands of a controller with the authority to order strikes.
- Put strike assets on the targets before those targets evade observation.

Current forces can do some of these things and, under the right conditions, are likely to be successful against some elusive targets. However, they cannot routinely detect, identify, and destroy such targets. Without this ability, U.S. operational and strategic goals—for example, preventing ethnic cleansing or defending an ally from heavy missile attack—are unlikely to be met. Thus, new technologies, concepts, and procedures will be necessary to gain an edge on elusive targets.

The United States Air Force should take the lead in identifying and testing the most promising technologies and concepts. GMTI and SAR ATR software, air-dropped UAVs, air-dropped ground sensors, hypersonic weapons, and small autonomous or semi-autonomous weapons are all representative of the types of technologies that will need to be developed to solve this problem.

MR-1398-AF, *Aerospace Operations Against Elusive Ground Targets*,
Alan Vick, Richard Moore, Bruce Pirnie, John Stillion

NATO Enlargement 2000–2015: Implications for Defense Planning

As part of its post–Cold War strategy, NATO has embarked on the twin processes of enlargement and transformation. The first round of post–Cold War enlargement occurred in 1999, with the accession of Poland, the Czech Republic, and Hungary. NATO’s transformation also dates from the 1990s, when the alliance, while reaffirming its commitment to the collective defense of its members, expanded its mission to include conflict prevention and conflict management throughout Europe, including areas outside the boundaries of the NATO treaty area. Both NATO’s enlargement and its transformation have been driven primarily by political imperatives, that is, by an environment-shaping agenda of democratization and integration rather than threat-based military rationale. There is good reason to believe that the two processes have been a major cause of the benign security environment that has prevailed in Europe since the second half of the 1990s, an environment characterized by the absence (or extremely low incidence) of armed conflict and the lack of near-term potential for a major war. To a large extent, NATO’s enlargement and transformation have functioned, respectively, as the proverbial carrot and stick. The enlargement offers a positive incentive for peaceful and cooperative relations in Europe, while the transformation holds out a negative incentive in the form of the alliance’s commitment to enforce peace and deter aggression, as demonstrated in the 1999 Operation Allied Force against Yugoslavia.

The prospect of NATO’s continuing enlargement has important military implications. This study provided an analytical framework for thinking about the determinants of future enlargement, the defense challenges posed by the integration of new members, and the strategies needed to respond. One challenge for defense planning lies in the fact that, by taking on a larger responsibility for European security as a whole and identifying specific countries as possible future members, NATO has extended implicit and conditional security guarantees to many nonmember states. A second challenge arises from the difficulty of integrating the military forces of potential new members, particularly former communist states, into the alliance. Membership in NATO entails a special level of cooperation, trust, and specific preparation for joint operations; and, because the credibility of NATO’s collective defense commitment is at stake, new and potential members have to achieve high levels of interoperability with the alliance. To facilitate the integration of new members, the United States and its

NATO allies can use their influence to help shape the choices made by potential members in developing and transforming their armed forces.

NATO Has Explicit and Implicit Criteria for Considering Accession of New Members

As a first step to understanding the specific defense challenges posed by new members, the RAND study employed an analytical framework to assess the likelihood of accession for prospective member states. A total of 12 countries are conceivably candidates for membership in NATO in the next 15 years, although only a few of them are actually likely to join NATO in that time frame. Nine countries have been identified by NATO as being on track to membership through the Membership Action Plan (MAP). The other three potential members are European Union (EU) members not currently in NATO; depending on the evolution of internal debates in these countries, any or all of them could decide to seek NATO membership during the next 10–15 years. This research assessed the likelihood of membership for the 12 countries according to the political, economic, and military preconditions for membership outlined by the alliance as well as the implicit, but no less important, strategic rationale for NATO to invite a particular country to join the alliance. All of these criteria played a role in the process leading to the 1999 enlargement. In the study, prospective members were first evaluated according to a scale constructed to match the five main preconditions for membership outlined by NATO in its 1995 study on enlargement:

- a functioning democratic political system
- democratic civil-military relations
- treatment of minority populations in accordance with democratic governance
- a functioning market economy, and the ability to make a military contribution to the alliance.

The resulting assessment was supplemented by an analysis of the strategic costs and benefits entailed by a given country's accession to NATO. Each country's strategic position was assessed according to four criteria:

- relevance to NATO's ability to project power in areas of likely contingencies
- creation of interior and easily defensible borders within the alliance
- risks that may accrue from a higher level of commitment to a new ally

- added transaction costs of a new member for the alliance’s cohesion and ability to perform its main missions on the basis of consensus.

The military forces of prospective members also were assessed according to each country’s ability to contribute to power projection missions and sufficiency for deterrence and border defense. The prospective members analyzed in the study, along with current NATO member states, are shown in the figure.



Current and Prospective NATO Members

Using the criteria outlined above, these findings emerged regarding the “long list” of potential NATO members. Of the MAP states, Slovenia and Slovakia largely meet the criteria outlined by NATO, and their accession poses no major

strategic problems for NATO. Estonia, Lithuania, and Latvia are advanced in terms of meeting NATO's preconditions, but the strategic ramifications of their accession loom large. Bulgaria and Romania have the opposite problem of being unable to meet NATO's preconditions even though the strategic implications of their accession are not problematic. Macedonia and Albania are least advanced in meeting NATO's preconditions, and their prospects for membership are distinctly long term. Of the European Union members currently not in NATO, Austria is in good position to join if it chooses to do so. To a lesser extent, so is Sweden. Finnish membership, however, would entail some difficulties because of the strategic cost it would impose on NATO.

The assessments just described are in no way permanent. They are based on the current state of internal post-communist transformation in the MAP states and on NATO's contemporary focus of attention on the Balkans. The assessments are subject to considerable uncertainty, particularly in the event of an unexpected shift in the security environment that currently prevails in Europe.

Most of all, the assessments above are not policy recommendations on which members should or should not be invited to NATO. Instead, they are a necessary first step for thinking about a long-term shaping strategy regarding the MAP countries and the specific activities that the strategy may entail for NATO, the U.S. European Command, and its service component commands.

Aspiring Members Pose Significant Defense Challenges for NATO

The RAND study analyzed the current status and future direction of the reform of the armed forces in prospective member countries. All MAP countries face challenges in their attempts to reshape their military forces. The main problems are summarized below.

- **Low technological sophistication and training and readiness levels.** Over the next 10 to 15 years, individual MAP states have the potential to make only minor (though not irrelevant) military contributions to the alliance in terms of collective defense and power projection.
- **Limited defense budgets.** For the foreseeable future, the defense budgets of the MAP states (except for Slovenia's) will be much smaller than those of current NATO members of similar size.
- **Acute problems with air forces and air defense.** The armed forces of only three MAP states (Slovakia, Romania, Bulgaria) have experience with advanced (fourth-generation) combat aircraft, and even these forces provide inade-

quate training to air crews (by NATO standards). The others currently possess little equipment of any kind and lack the ability to ensure their own air sovereignty.

From a defense planning perspective, one of the most significant issues for the United States and its NATO allies is the paradoxical relationship between a country's likelihood of joining NATO and its need for security. The MAP countries least likely to join NATO in the near term cannot provide much of a deterrent in the event of an unexpected crisis, and, as a result, are most in need of NATO's security guarantee, a situation that is likely to continue for a considerable length of time. In contrast, those countries most likely to join are least in need of the security guarantee.

The United States and Its Allies Can Help Shape the Armed Forces of Prospective Members

The process of integrating the armed forces of the MAP states into NATO will be long and difficult, but these problems are neither insurmountable nor unexpected. With a well-thought-out long-term plan of development, wise investments in modernization, and increased operations and maintenance spending, the armed forces of the MAP states eventually could make a meaningful, if small, military contribution to NATO, on a par with that of many current members. This is where NATO's shaping incentives come into play. The alliance can help shape the choices the aspiring members make in their plans toward greater efficiency and effectiveness.

Indeed, NATO is in a good position to help shape the development of the armed forces of the MAP states to the benefit of both the alliance and the prospective members because the possibility of NATO membership serves as an inducement to the prospective members to adjust to NATO's preferences regarding force development. The MAP states stand to contribute more to NATO if, instead of building up their forces across the board, they build on existing strengths and focus on the prospective missions their armed forces might undertake. Greater specialization, with an emphasis on ground forces, will provide prospective members with a stronger deterrent and a lower likelihood that NATO will be called on to provide assistance and reinforcement. Although the alliance does not have the same level of influence over the force plans of non-NATO EU members (Austria, Sweden, Finland), NATO can nonetheless encourage these countries to maintain and develop their forces in a way that would allow for easy integration into NATO at a future date.

An appropriate strategy for the United States toward the MAP states should be individually tailored to each country while incorporating an understanding of five key issues:

- the potential strategic exposure and need for NATO reinforcement that accompany hypothetical threats to a MAP state under crisis conditions
- the time frame for a MAP state likely joining NATO
- the severity of the problems a MAP state faces with its armed forces
- the means available to a MAP state for addressing the problems of its armed forces
- the likely useful (technologically sophisticated and well-trained) contribution of a MAP state to NATO's peace operations.

MR-1243-AF, *NATO Enlargement 2000–2015: Determinants and Implications for Defense Planning and Shaping*, Thomas S. Szayna

Operation Allied Force: Lessons for Future Coalition Operations

On March 24, 1999, NATO initiated Operation Allied Force as a means to compel Slobodan Milosevic to cease ethnic cleansing in Kosovo and to pull Serbian forces out of the disputed province. Although initially expected to last a few days, the operation did not conclude until June 10, 1999—78 days later—when Milosevic agreed to NATO's terms. Operation Allied Force marked a watershed in the alliance's history and a significant departure from NATO's exclusive Cold-War focus on the defense of its members' borders. As demonstrated in the Kosovo campaign, the alliance's new missions can involve crisis response and crisis management throughout Europe, including countries outside the NATO treaty area. In Operation Allied Force, the alliance showed itself capable of acting when challenged even in circumstances where the territorial integrity and sovereignty of NATO's members were not directly affected.

But what lessons can Operation Allied Force offer to the United States and Europe in preparing for future coalition operations? The research team found that, despite the success of the campaign, the experience of Operation Allied Force reemphasized the growing gap in military capabilities between the United States and Europe. The campaign displayed the difficulty of establishing and maintaining consensus in coalition warfare in which intra-alliance political consultations are essential to produce any military action. It also highlighted differences in the perspectives of the United States and the European countries regarding such issues as the appropriate use of force and the legal basis for coalition operations.

The study concluded that the United States should expect to continue to play the major role in future coalition operations. However, the Europeans should anticipate continuing pressure from the United States to improve their defense capabilities in the near term, particularly in the areas of deployability and sustainability. NATO's training exercises provide an opportunity for alliance members and potential members to practice the skills needed for coalition warfare, including the consultations and deliberations required for consensus.

Lessons of Operation Allied Force

Operation Allied Force was officially supported by all 19 members of NATO. Thirteen countries contributed military aircraft to the operation, with France making the greatest contributions among the European countries in terms of deployed aircraft assets. According to the researchers, several key lessons emerged from NATO's 78-day operation in Kosovo:

Although alliance and U.S. media news releases during the operation recognized the contributions of all participating air forces, the United States was responsible for a disproportionately large share of the effort. The Europeans certainly made some important contributions to combat operations. Germany and Italy played an important role in the campaign to suppress enemy air defenses, while the British and French joined the United States in delivering precision-guided munitions. However, the allies generally lacked the level of precision and all-weather capabilities that would allow them to carry out their missions by day and night while ensuring minimum civilian damage. The United States provided 700 of the 1055 aircraft deployed in the allied effort and flew by far the greatest number of sorties. The Europeans also lacked capabilities to deploy personnel and equipment to the field of operations and to sustain them as long as necessary. The United States provided more than 90 percent of aerial refueling aircraft, the bulk of airlift capabilities, and all tactical jamming capabilities.

Intra-alliance politics made Operation Allied Force possible but also resulted in political and operational constraints that imposed limitations on warfare. The conditions of coalition warfare produced a relatively slow, deliberate air campaign, in contrast to the U.S. preference for high-tempo, continuous operations and overwhelming levels of force. The slower style of campaign was necessary to accommodate the consultative and deliberative functions of the coalition and to secure domestic and international popular support for the operation. Public support depended in large part on assurances that the risk of civilian casualties and damage was low. To minimize this risk, the alliance limited the size, pace, targets, and amount of force used in the campaign.

Despite years of multinational, cooperative planning within the alliance, the allies found it difficult to agree on a common approach. The consensus for action was fragile in the absence of an immediate threat to allied territory or traditional interests. Disputes within the alliance centered on three issues: whether a "gradualist" approach to the air war would succeed, whether the United States had the right to keep some sensitive information in U.S.-only channels, and whether ground forces should be introduced. The last issue

proved to be particularly contentious, even though none of the NATO members were eager to deploy ground forces. Ultimately, the discussion surrounding this issue may have helped sustain the consensus to continue the air campaign by reinforcing a shared belief that introducing ground forces would involve even more difficult and unpleasant issues.

Operation Allied Force highlighted some key differences in the perspectives of the United States and the European countries. The U.S. decision to maintain some information in U.S.-only channels occurred out of concern over the increased potential for information leaks in coalition operations. But many European countries resented the United States for what they considered to be overbearing control that excluded them from many decisions and minimized their involvement in others. In addition, many of the European allies were deeply uncomfortable with the legal basis of Operation Allied Force, which was carried out without the authorization of the United Nations or the Organization for Security and Cooperation in Europe (OSCE). In contrast, the United States argued that the NATO treaty provided adequate justification for the alliance to act wherever its interests were threatened.

Steps to Prepare for Future Coalition Operations

In light of the experience of Operation Allied Force, alliance members must resolve several important issues to prepare for future coalition operations. Key steps can be taken by the United States and the European countries individually, as well as by the alliance as a whole, to improve their capabilities for future coalitions.

The United States. The United States and especially the U.S. Air Force should expect to continue playing the role of allied force integrator in future coalition operations. Because of its military dominance, the United States has considerable leverage in designing military operations. During future campaigns, the United States may find it preferable to forge a consensus for more-vigorous action—even at the cost of some allies' participation. In the meantime, the United States can encourage allies to improve their military capabilities, particularly in the areas of deployability and sustainability. The United States should advocate that allied air forces emphasize multipurpose capabilities so that they can effectively participate in the full spectrum of operations—whether the coalition is producing overwhelming force or flying a handful of sorties a week. The United States should also support the development and use of NATO training exercises and scenarios that require participants to practice the consultations and deliberative actions needed for coalition operations.

NATO. Individually and collectively, the alliance has much to grapple with from Operation Allied Force. The researchers identified six major issues demanding immediate attention:

- *Command structures.* The alliance should ensure that command structures are optimized for coalition operations, providing, at a minimum, a basic framework for headquarters and their subordinate units, complete with appropriate communications architectures.
- *Defense Capabilities Initiative (DCI).* NATO officially launched the Defense Capabilities Initiative in 1999 as a means of improving the interoperability, deployability, and sustainability of NATO forces. The DCI has become a regular part of the annual NATO planning process during which member nations report the steps they are taking to improve their military forces. Since major additional defense spending among most of the allies is highly unlikely, the force planning process must adopt ways to prioritize those objectives the alliance really wants its members to accomplish, such as deployability and sustainability.
- *Alliance-based assets.* NATO should consider expanding the number of alliance-based assets to include capabilities for intelligence, surveillance and reconnaissance, and electronic warfare.
- *System for operational decisions.* A more responsive system is needed to allow NATO to request forces and assets from its members and to make operational decisions such as targeting.
- *Doctrine and military practices.* The alliance should investigate new ways to forge agreements on doctrine and military practices in a way that will approximate a common operational approach.
- *Consultation process.* NATO must perfect and institutionalize a process of consultation and deliberation among its members.

The European countries. Individually, the European countries—including non-NATO states—face several challenges in their attempts to make progress toward capable, deployable, and sustainable forces within constrained budgets. Improvements may require tradeoffs. Some countries may opt to reduce force size in order to finance modernization or to divert funding to certain key capabilities while allowing shortcomings in less-critical areas. Particularly important will be investments in complete, coherent, air-ground force packages.

One complexity in the development of European militaries concerns the role of the European Union (EU), whose membership overlaps with but does not duplicate

the NATO roster. The EU is currently working to create a military capability to complement its economic and political capabilities. The EU is in the process of developing the institutions that will constitute the European Security and Defense Identity (ESDI), which will establish an independent European security and defense policy. At this time, the critical unanswered question about ESDI is its future relationship with NATO. The EU must ensure that the ESDI continues to develop in a way that complements and does not compete with NATO. The ESDI could potentially benefit NATO by promoting interoperability, deployability, and sustainability across the EU, thereby expanding the pool of potential coalition partners.

Implications for Future Coalitions

Drawing upon the lessons of Operation Allied Force, the research team recommends the following to guide planning for future coalition operations:

- Because future coalitions may contain widely different capabilities, it will be necessary to design plans in such a way to allow all units to contribute. In most cases, the coalition leadership will have to be innovative to find effective roles for all participants.
- It is possible that future coalitions may face circumstances in which some alliance members participate in the humanitarian and peacekeeping phases of an operation, but not in combat should it occur. In some cases, members may not support the operation at all while non-NATO countries and even non-European countries choose to participate. Future coalitions must be prepared for such challenges to ensure that those states that do opt out do not restrict the range of options available to those states committed to combat.
- Future coalitions may take place under conditions in which military operations are subordinate to political and diplomatic efforts that place limits on the scope of military action. In such circumstances, coalitions will have to be very creative to find ways to deliver appropriate and effective levels of military leverage that support political-diplomatic initiatives within the prescribed limitations.
- A potentially serious consequence of coalition operations is that they may leave the enemy in power and in a position requiring further international supervision, such as the designation of no-fly zones. In each situation, future coalitions must determine the best course of action by weighing carefully the relative consequences of leaving an adversary intact or forcing him from power.

- More systematic efforts must be made to collect and disseminate lessons learned from coalition operations and respond to them. The United States currently has some systems in place that can serve as models.
- Multinational exercises are extremely important for ensuring interoperability with potential coalition partners and for working out command issues. NATO should improve its capability for exercises so that it can routinely integrate coalition-building and maintenance activities with military actions.

MR-1391-AF, *European Contributions to Operation Allied Force: Implications for Transatlantic Cooperation*, John E. Peters, Stuart Johnson, Nora Bensahel, Timothy Liston, Traci Williams

NATO's Air War for Kosovo: A Strategic and Operational Assessment

On March 24, 1999, NATO forces initiated an air war against Serbia in an effort to put an end to the human rights abuses that were then being perpetrated against the ethnic Albanian population in Kosovo. This bombing effort, code-named Operation Allied Force, ended 78 days later with the capitulation of Yugoslavia's president, Slobodan Milosevic, and the subsequent withdrawal of Serbian army and paramilitary forces from Kosovo. Yet despite its success in bringing about Milosevic's defeat, Operation Allied Force was a suboptimal use of air power to resolve a regional conflict. Although NATO's air offensive ultimately proved crucial to Milosevic's decision to submit to NATO's terms, a host of deficiencies—both strategic and operational—protracted the air effort and hampered its overall effectiveness. Figure 1 shows a map of the immediate area of operations.

The study undertook a thorough appraisal of Operation Allied Force, with a view toward shedding light both on the operation's strengths and on its most salient weaknesses. After outlining the main highlights of NATO's air offensive, it examined the various factors that interacted to induce Milosevic to capitulate when he did. It then explored air power's most notable accomplishments in Allied Force, as well as the many problems and sources of friction that hindered the operation both in its planning and in its execution. Finally, the research assessed Operation Allied Force from a political and strategic perspective, calling attention to those issues that are likely to have the greatest bearing on future military policymaking.

Why Milosevic Conceded: A Step Back

Although NATO's bombing effort in the end played the determining role in bringing about Milosevic's defeat, a host of additional factors also figured importantly in this respect. In addition to the damage that was being wrought by NATO's air attacks, for example, another factor that very likely contributed to Milosevic's surrender was the sheer depravity of Serbia's conduct in Kosovo, which ultimately stripped it of what little remained of international support, most notably from the Russians. Yet another element that may have come into play was pressure from Yugoslavia's elite, on whom NATO's bombing of key industrial and economic interests in and around Belgrade had begun to take an intensely personal toll.



Figure 1—The Operations Arena

Milosevic was, in addition, almost surely aware of the growing potential for a ground invasion as NATO's air war progressed. By the end of May 1999, it had become clear that NATO had increasingly accepted the need to go ahead with a ground invasion in the event that its air effort alone failed to bring about a decisive outcome. Although senior officials in Washington remained highly resistant to proceeding with that course right up to the very end, Milosevic cannot have failed to apprehend the implications of such a possibility.

At the same time, Milosevic was bearing witness to an escalating air war that showed no signs of abating (Figure 2). Although NATO's efforts to find and attack dispersed and hidden enemy forces in Kosovo had proved largely ineffective, an increasing number of infrastructure targets were being hit each day, and these attacks were taking a mounting toll both on Yugoslavia's leadership and on the population as a whole. It is thus likely that NATO's air offensive ultimately convinced Milosevic that the alliance not only intended to persist in its attacks but was determined to prevail. In the end, the sustained bombing, although by no means the sole factor responsible for the success of Allied Force, set the stage for Milosevic's capitulation by making it clear that he had little to gain by holding out.¹

¹For a fuller treatment of this thesis, see "Why Milosevic Decided to Settle the Conflict Over Kosovo When He Did," page 5.

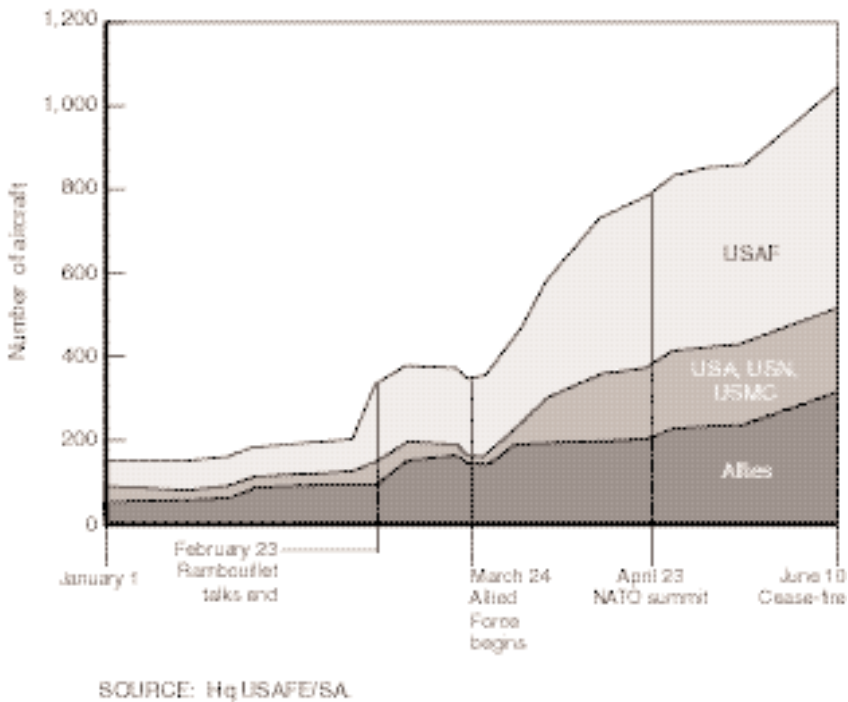


Figure 2—Conflict Timeline

Operational Issues: The Air War in Action

Much of the controversy surrounding Operation Allied Force has pivoted on the discrepancy between what the NATO allies expected and what they ultimately encountered. Although NATO initially sought to neutralize Serbia’s air defenses, the alliance soon discovered that the Serbs kept most of their surface-to-air missiles dispersed with their radars not emitting, rendering them difficult to find and attack. At the same time, the Serbs’ heavy man-portable air defenses and anti-aircraft artillery forced NATO aircrews to conduct bombing attacks from an altitude of 15,000 ft or higher, which sometimes hampered the visual identification of targets and the ability to distinguish between military convoys and civilian refugees. Mobile enemy troops in Kosovo also proved to be more capable and tenacious foes than had been anticipated. Operating under the cover of inclement weather and shielded by mountainous terrain, Serb forces were frequently able to disperse and conceal their weapons, thereby eluding allied efforts

to find and attack them in a timely way. This shortcoming protracted the overall allied effort, eventually occasioning a more determined pursuit of infrastructure targets in and around Belgrade.

Despite unprecedented pressure to avoid civilian casualties and unintended collateral damage, Operation Allied Force also fell prey to a number of bombing errors, including the widely publicized inadvertent bombing of the Chinese embassy in Belgrade. Although some of these errors were a natural consequence of NATO-imposed operational constraints and Serbia's uncongenial spring weather, the extraordinary media attention that was paid to them further detracted from the overall effectiveness of the campaign by starkly showing what can happen when achieving zero collateral damage becomes not just a desired goal of allied strategy but also the expectation.

Strategic Issues: An Overview

Operation Allied Force left in its wake a number of questions regarding its overall strategy and execution. To begin with, allied planners erred badly at the very outset of the campaign by failing to appreciate Kosovo's profound historical and cultural significance to the Serbs. This critical error in judgment led to the allies' flawed assumption that Milosevic would capitulate to NATO demands without the need for an aggressive or protracted engagement. NATO's operation in Kosovo was further hampered by the need to achieve consensus among its politically diverse member states, many of which were hesitant to use significant force in what was essentially a humanitarian operation. This requirement for unanimity on at least the basics of allied strategy led not only to the outright rejection of a ground option from the very start but also to the imposition of exceptionally stringent rules of engagement. Added to this mix of coalition restraints were internal disagreements within the U.S. component of the alliance over target priorities and broader force employment strategy, which further undermined the effectiveness of NATO's efforts.

NATO's Air War in Perspective

Operation Allied Force was the most intense and sustained military operation to have been conducted in Europe since the end of World War II. It also represented the first extended use of military force by NATO as well as the first time air forces had successfully coerced an enemy leader in the absence of significant friendly ground-force involvement. Although the operation failed to halt Milosevic's ethnic

cleansing campaign, it succeeded in reversing that campaign by forcing Milosevic to accede to NATO's demands.

At the same time, NATO's air war suffered from a number of critical shortcomings. On an operational level, the allies' attempts to find and attack dispersed and hidden enemy ground forces in Kosovo proved largely unsuccessful, enabling Milosevic to accelerate his ethnic cleansing campaign against the Kosovar Albanians even as NATO's bombing efforts intensified. On a strategic level, the operation's desultory onset, restrictive rules of engagement, and ill-conceived strategy hobbled the allies' effort by compromising their ability to engage a wily and determined foe. In the end, Operation Allied Force's most noteworthy distinction may lie in the fact that the bombing effort prevailed despite the myriad impediments it faced. In light of that, perhaps the most telling lesson to be drawn from Operation Allied Force is that however capable air forces may have become in principle compared to other force elements, they can never be more effective than the strategy they are intended to support.

MR-1365-AF, *NATO's Air War for Kosovo: A Strategic and Operational Assessment*, Benjamin S. Lambeth

Balancing Strategy, Forces, and Resources: Lessons for the Current Defense Review

The post–Cold War era has been one of immense change, and one that has created equally immense challenges for defense planners. Changes in the international environment and the nature of threats to U.S. interests—as well as the size of defense budgets—have placed tremendous strain on the U.S. policymakers who sought to achieve a balance between strategy, forces, and resources. The question of how best to achieve such a balance resurfaced with the defense reviews of 2001.

RAND researchers provided a context for understanding the challenges facing defense planners during the recent defense review by examining the experience of the 1989–1990 Base Force, 1993 Bottom-Up Review, and 1997 Quadrennial Defense Review. The study defined the key assumptions, decisions, and outcomes associated with the development and implementation of each review. The analysis demonstrated the emergence of a growing gap between defense strategy, the force structure intended to support the strategy, and the amount of resources allotted to the defense program. It concluded that future defense reviews need to better assess how changes in strategy might potentially affect force employment and readiness. Increased attention also should be given to determining the true costs of funding a reasonable-risk strategy and force structure, and to the long-term modernization and transformation of the force.

The Base Force Marked the Post–Cold War Shift to a Regional Basis for Defense Planning

The 1989–1990 Base Force was in large part the response to a diminishing threat and demands for a “peace dividend” at the end of the Cold War, both of which were given further impetus by a deepening recession and soaring budget deficit. Central to the Base Force was a proposed 25-percent reduction in active forces below FY 1990 levels—considered the minimum force necessary to protect U.S. interests in the post–Cold War environment.

Strategy. The Base Force replaced the Cold War emphasis on global containment of the Soviet Union with a focus on regional threats to U.S. interests. While retaining the objectives of strategic deterrence and defense, the new strategy called for reductions in large standing forces overseas (“forward defense”) and

advocated greater reliance on rotational, mostly U.S.-based forces (“forward presence”) and crisis response capabilities. If needed, the force was to be able to reconstitute its former capabilities. Although the Base Force called for flexible general-purpose forces to address the entire “spectrum of threat” from humanitarian assistance and noncombatant evacuation operations to major regional conflicts, there is little evidence that Base Force planners anticipated, much less favored, substantial involvement in peacekeeping and other peace operations.

Forces. The size of the force was determined according to an assessment of capabilities needed to meet regional threats, not a capability to fight two major theater wars, a criterion that would become central to defense planners in the subsequent administration. Four force packages were oriented, respectively, toward strategic deterrence (Strategic Forces), forward presence (Atlantic and Pacific Forces), and crisis response and reinforcement (Contingency Forces).

Resources. Much of the planning for the Base Force was premised upon the 25-percent reduction in forces, coupled with a smaller, 10-percent reduction in long-term defense budget authority. However, the October 1990 budget summit required much deeper budget reductions of 25 percent. As a result, substantial additional defense cuts were made, especially to long-term modernization efforts.

Assessment of the Base Force

Many of the strategic assumptions underlying the Base Force remained salient through the rest of the decade. Among the most important of these was the need for a regionally based strategy that emphasized deterrence, forward presence, and crisis response. However, one of the Base Force’s key premises—that the post-Cold War world would not experience large-scale, long-duration contingency operations—was cast into doubt as a result of the need to sustain a presence in Southwest Asia after the Gulf War. Other key findings:

- The post-Gulf War experience in particular validated policymakers’ assumptions about one implication of the spectrum of threat: that the United States might be kept busy with a host of smaller and generally less-consequential military operations.
- While reductions to force structure and active manpower were achieved, reductions in reserve component manpower were delayed. Further, while the 1989 Base Realignment and Closure commission (BRAC) initially identified 40 bases for closure, concerns later arose that not all the anticipated savings would be realized from BRAC and other cost-reduction initiatives.

- Administration and congressional efforts to control the ballooning federal deficit resulted in further budget reductions after 1991, with more challenging problems—including a procurement “bow wave”—looming on the horizon because of the resulting insufficiency of funds to modernize the force.

The Bottom-Up Review Combined a More Ambitious Strategy with a Smaller Force Structure and Reduced Budget

The 1993 Bottom-Up Review (BUR) was the Clinton administration’s attempt to provide a “comprehensive review of the nation’s defense strategy, force structure, modernization, infrastructure, and foundations.” Central to the new administration’s plan were additional reductions in defense spending and force structure even while the administration was promoting a new defense strategy for the nation.

Strategy. The BUR’s strategy promoted increased U.S. participation in multi-lateral peace and humanitarian operations while continuing to embrace the Base Force’s regional focus and emphasis on strategic deterrence, forward presence, and crisis response. The BUR’s strategy focused on a host of “new dangers,” including the proliferation of weapons of mass destruction; large-scale aggression and ethnic, religious, and other forms of conflict; threats to democracy and reform in the former Soviet Union; and instability from the failure to build a strong and growing U.S. economy.

Forces. The BUR proposed force structure reductions of about one-third from FY 1990 levels and promoted additional manpower cuts of 160,000 active personnel and 115,000 civilians. The force structure was originally designed to support a U.S. military capability of winning one major regional conflict (MRC) while “holding”—and later winning—a second MRC (the “win-hold-win” strategy). But after criticism from Congress and allies, the administration opted for the military capability of winning two simultaneous MRCs. The original plans for force structure were not substantially changed, however, with the exception of some force enhancements in areas such as strategic mobility. The military strategy was to be supported by a set of “force building blocks” to address the needs of MRCs, peace enforcement and intervention operations, overseas presence operations, and deterrence of attack by weapons of mass destruction. The BUR considered peacetime and other smaller-scale contingencies (SSCs) to be “lesser-included cases” where the demands on the force could be managed. Accordingly, the BUR laid down an elaborate logic for disengaging the force from peacetime operations, and it established several management oversight

groups to monitor readiness and other risks that might arise as a result of participation in peace operations.

Resources. Despite its ambitious strategy, the BUR promoted deeper cuts to the defense top line. The BUR reported that it anticipated \$104 billion in savings from the Bush baseline budget, although some OSD policymakers are reported privately to have expected only about \$17 billion in savings. Constraints on resources meant that the BUR could undertake only “selective modernization” in areas such as the theater air program. The BUR also supported several so-called “new initiatives” directed at improving U.S. capabilities in areas other than traditional warfighting.

Assessment of the BUR

The BUR’s ambitious strategy ultimately was not adequately supported by the reduced and underfunded force structure. The BUR failed to fully reckon how peacekeeping and other smaller-scale operations would impact warfighting readiness. Readiness problems also emerged, while resource shortfalls resulted in increased risks associated with executing the national military strategy and postponed spending on modernization and other investments. Other key findings:

- The BUR’s emphasis on peace operations resulted in commitments throughout the 1993–1998 period that were frequent, large, and of long duration. By some accounts, this commitment ultimately amounted to the equivalent of a major theater war’s worth of forces.
- Reductions to force structure were achieved relatively quickly, but infrastructure reductions lagged.
- The actual costs of the defense program turned out to be much higher than anticipated, with only about \$15 billion in savings realized over FY 1994–1999. In addition, some of the force enhancements required to make the two-MRC strategy work (e.g., in the area of strategic mobility) were not in place as expected by 1999. Spending on modernization fell well below the planned levels, while funds routinely “migrated” from investment accounts to operations and support accounts.

The Quadrennial Defense Review Sought to Rebalance the Defense Program and Budget

The Quadrennial Defense Review (QDR) was intended as a blueprint for a strategy-based, balanced, and affordable defense program. With a flat budget of \$250 billion, only modest adjustments to force structure, and about a 10 percent reduction in manpower, the QDR aimed to address some of the key problems that developed during the BUR years, including the “migration” of funds.

Strategy. The QDR’s strategy embraced both active engagement and crisis response operations, while seeking to ensure resources for modernization of the force. Dubbed “shape, respond, and prepare now,” the strategy generally reaffirmed the BUR’s emphasis on two nearly simultaneous MRCs as the principal basis for force sizing. The QDR also placed increased emphasis on the quick deployment of forces to halt an advancing enemy army (“the halt phase” in major theater war). It gave greater recognition to the possibility of multiple concurrent SSCs, although it continued the BUR’s practice of treating SSCs as “lesser-included cases.” It also articulated a somewhat more nuanced employment doctrine that distinguished among vital, important but not vital, and humanitarian interests.

Forces. Changes to force structure involved only modest reductions as well as some restructuring. Instead, savings were to be achieved largely through manpower cuts. The QDR reported target reductions of 60,000 active forces, 55,000 reserve forces, and 80,000 civilians.

Resources. The QDR anticipated continued flat defense budgets while seeking a long-term commitment to achieve \$60 billion a year in procurement spending by 2001, an amount which would allow only continued selective modernization. To make the overall program affordable, the QDR made selective cuts to a number of acquisition programs, and sought further infrastructure reductions and defense management reforms.

Assessment of the QDR

The QDR did not resolve the imbalances that had developed over the implementation of the BUR. In fact, its flat budget underestimated the resources needed to support the defense program. By the fall of 1998, the service chiefs reported serious readiness problems and said that the risks associated with executing the two-conflict strategy had increased. Other key findings:

- Although the QDR had anticipated continued participation in peace and other contingency operations, actual U.S. participation in such operations turned out to be much higher than expected.
- The modest force structure changes recommended by the QDR were in place by FY 2001. While the other services were expected to hit their QDR manpower targets by 2003, the Air Force's execution of the QDR manpower cuts over FY 1997–1999 was delayed. Further rounds of base closures were not authorized by Congress.
- Most programs advocated as part of the selective modernization of the force continued to receive reasonably robust levels of funding. However, long-range modernization plans remained at risk due to the continued migration of funds from procurement to operations accounts. The combination of the seriousness of readiness and other challenges, as well as emerging federal budget surpluses, led to an infusion of an additional \$112 billion to the defense program beginning in FY 2000. This increase proved far from sufficient to recapitalize the aging force, however.

The Current Defense Review Will Need to Address Problems of Strategy, Long-Term Modernization, and Adequate Resources

The defense reviews shared certain common features. All assumed that the most important post–Cold War mission for conventional forces was halting and reversing cross-border aggression by massed, large-scale mechanized forces. Each in its own way treated smaller-scale peace and other contingency operations as “lesser-included cases” that could be successfully managed by a force structure that was primarily designed for warfighting, and each assumed that these operations would impose minimal costs and risks on warfighting readiness. Moreover, each suffered from the absence of a bipartisan consensus on a post–Cold War foreign and defense policy and on how to rectify the emerging gaps in the defense program.

The study identified three key lessons from the experience of the past defense reviews with implications for the current review:

- It is critically important to understand fully the ramifications brought about by changes in strategy. The conception of engagement documented in both the BUR and the QDR promoted peace operations as an important tool of U.S. policy, which had strong implications for the resulting pattern of U.S. force employment. However, neither review fully acknowledged the potential

effects of this element of strategy or anticipated the resulting readiness problems and increase in warfighting risks. The current review will need to better assess the relationship between the chosen strategy and force structure.

- Increased focus should be given to the long-term modernization and transformation of the force to ensure that the United States is able to retain—and even expand—its qualitative advantages over potential adversaries. While there have been substantial reductions in force structure and manpower, only a modest amount of reshaping of the force has taken place. Efforts to transform the force have so far been hampered by a continued focus on current-day threats, force structure, and readiness needs—at the expense of addressing longer-term needs.
- It is necessary to determine the true costs of a reasonable-risk version of strategy and force structure. In past reviews, an avoidance of debates over strategy, policy, and the adverse impacts of defense discretionary spending caps may have impeded consideration of the problems that have plagued the defense program for much of the decade.

The Bush administration's quadrennial defense review will wrestle with the same questions faced by its predecessors in defining and funding a strategy and force structure that can best serve the interests of the United States. In answering these questions, the Department of Defense would profit from an "assumption-based" planning approach that establishes signposts for evaluating the continuing validity of the key assumptions employed in planning. Assumptions to be evaluated include future threats; the anticipated mix, frequency, and concurrency of future operations; the adequacy of forces to undertake these operations; and the resources that are necessary to ensure high readiness and low-to-moderate risk in executing the national military strategy.

MR-1387-AF, *Defense Planning in a Decade of Change: Lessons from the Base Force, Bottom-Up Review, and Quadrennial Defense Review*, Eric V. Larson, David T. Orletsky, Kristin Leuschner

Airspace and Ranges: Linking Infrastructure Needs to Mission and Training Requirements

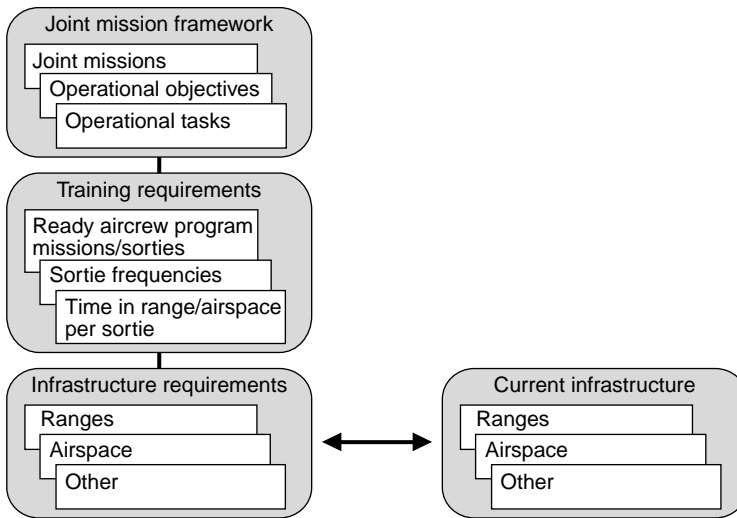
Training Air Force aircrews for combat requires access to ranges suitable for actual or simulated weapons delivery and to dedicated airspace suitable for air-to-air and air-to-ground tactics. Since ranges and airspace are scarce national resources, Air Combat Command (ACC) must present a credible claim for their use. ACC Headquarters asked RAND for assistance in determining its requirements, assessing the adequacy of existing assets, and justifying new or existing assets. The research team, working in concert with ACC, responded by creating an analytic structure that links range and airspace requirements to national defense interests and offers a means of comparing these requirements to currently available infrastructure.

A New Analytic Structure

Because sufficiently detailed information about operational requirements, aircrew training needs, and existing range and airspace infrastructure was not available, researchers examined ways of improving the collection, evaluation, analysis, and presentation of such information. The research team concluded that the most effective approach was to develop an analytic structure containing the following elements:

- Operational requirements that aircrews must be trained to support
- Training tasks needed to prepare aircrews for these operational requirements
- Range and airspace characteristics needed to support each training task
- Relational links among operational requirements, training needs, infrastructure needs, and available assets.

The figure shows the elements of the analytic structure.



Elements of the Analytic Structure

A Relational Database for Current and Future Needs

This approach called for extensive details about key elements of the framework as well as a means of representing relationships among them. The study team developed a relational database that would not only serve the analytic needs of the project but could also be updated to reflect changes in training requirements or existing assets and expanded as necessary to capture other management information. Ideally, elements to be included in the database would be developed through analysis of empirical data. Unfortunately, neither detailed training data nor appropriate metrics about operational effectiveness were available. The most obvious option—establishing the necessary metrics, capturing the training and performance data, and continually analyzing this data—would be extremely expensive.

The RAND team chose instead to populate the database by relying on expert judgment. In some cases, the research team found the necessary expertise within its staff. In other cases, it relied extensively on judgments and inputs from experienced aircrews and range/airspace managers in headquarters, training, and operational units. Whenever possible, the team enhanced the objectivity and replicability of these judgments through careful analysis of the underlying operational and training processes. The goal was to make the expert judgments visible and credible both inside and outside the Air Force.

Assessment of Existing Assets

Using the information captured in the database, the study assessed current ranges and airspace assets used by ACC units. To be useful for training, range and airspace infrastructure must have certain geographical, qualitative, and quantitative characteristics. Geographically, it must be reasonably proximate to base operating locations. Qualitatively, the infrastructure must have minimum dimensions, equipment, authorization for operating aircraft and systems in specified ways, as well as other characteristics. Quantitatively, the time available on proximate ranges and airspace must be sufficient to support the training requirements at an operating base.

The study showed that there were no significant problems with proximity of ranges and airspace to home bases for air-to-air sorties, but found some proximity problems for air-to-ground sorties. For A-10s at Pope Air Force Base and F-16s at Moody Air Force Base, aircrews get less actual air-to-ground training time than their counterparts at other bases because of significant geographical separation from the ranges and airspace needed for training purposes. For bombers, crews at several bases have to cover inordinate distances in order to drop a bomb or launch a standoff weapon.

Qualitatively, the study found that large proportions of fighter sorties are flown using routes, maneuver areas, and ranges with substandard dimensions. For example, the proportion of sorties flown in maneuver areas with adequate lateral dimensions ranges from a low of about 30 percent for OA-10s to a high of about 70 percent for F-15Cs. There were also widely observed deficiencies in scoring and other feedback systems, targets, chaff and flare use authorization, ordnance types permitted, threat emitters, terrain variety, and other characteristics. Collectively, these deficiencies make it difficult for crews to experience, and learn to react to, the threats and conditions they must be prepared to face in combat.

Quantitatively, the research indicated that all almost all fighter bases have access to sufficient range capacity to meet annual air-to-ground sortie requirements, although not necessarily on their own ranges. Aircrews at only one base, Davis-Monthan, seem to have insufficient access to their available range. Additionally, aircrews at two other bases, Pope and Moody, find available training time only by splitting their sorties between two ranges.

Ongoing Uses of the Database

The database developed for this study is a powerful tool for ongoing evaluation of range and airspace assets—and for providing information that will help the Air Force determine and defend required access to these assets. The database may also prove useful for a larger staff client base than originally conceived: It can support flying training requirement analysis, base/unit beddown evaluation, and program planning. No matter what purposes it serves, however, this decision support system can remain effective only if managed by a trained database administrator and updated by staff and field personnel who have learned to appreciate and routinely use the system's capabilities.

MR-1286-AF, *Relating Ranges and Airspace to Air Combat Command Missions and Training*, Albert A. Robbert, Manuel Carrillo, Robert Kerchner, Willard Naslund, William A. Williams

F-15 Avionics Intermediate Maintenance Options for Expeditionary Air Force Support

In the current Air Force support system for F-15 avionics, each base with F-15 aircraft has an avionics intermediate-maintenance shop (AIS) for repairing avionics line-replaceable units (LRUs)—components that are removed and replaced by flight-line mechanics. Under present policy, the AIS is deployed with aircraft from home bases to forward operating locations (FOLs) in a decentralized-deployment support option. This system places a heavy deployment burden on avionics personnel and requires substantial airlift for the AIS equipment. Also adversely affected are the Expeditionary Aerospace Force (EAF) goals of increasing response speed, reducing strain on personnel, and diminishing the deployment footprint—or the amount of materiel that must deploy with a force.

What F-15 avionics maintenance options might the Air Force consider in its efforts to achieve EAF goals? RAND researchers examined alternatives that eliminate or reduce AIS deployments by providing spare-parts replenishments to FOLs through distribution rather than local repair, comparing these alternatives both to each other and to the current system. These include

- the current decentralized-deployment system
- a decentralized-no-deployment system in which each AIS supports deployed aircraft from home instead of deploying with aircraft to FOLs
- a single continental United States (CONUS) support location (CSL) with consolidated repair for worldwide support in both peace and war
- a CSL in network with two, three, or four regional repair forward support locations (FSLs) that would support operations in both peace and war.

Figure 1 presents a notional support structure comprising four FSLs and one CSL located at existing and hypothetical bases.

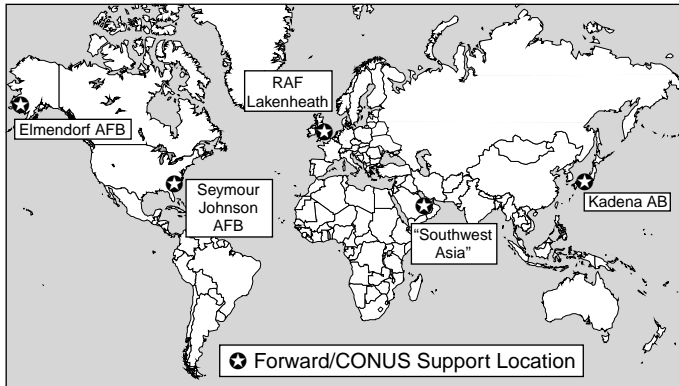


Figure 1—Notional Four FSL and One CSL Structure

The analysis focused on the system costs, deployment requirements, and operational risks associated with each of these alternatives. The research team also considered how technological change and the transformation of current processes would affect system performance in meeting EAF goals. They determined, for example, how faster order-and-ship times (OSTs) and implementation of the Electronic System Test Set (ESTS) being developed to reduce deployment footprint and personnel requirements would affect comparisons between support structure alternatives.

System Costs

To compare the costs of the various alternatives, the researchers calculated the present value of operating and investment costs and found that the consolidated alternatives reduce annual operating costs in exchange for initial investments in F-15 avionics serviceable spare parts. The level of consolidation affects the balance of this tradeoff in that greater consolidation yields the most significant reduction in personnel costs, but this gain is offset by even greater increases in spare-parts requirements as well as by lesser increases in transportation costs. The net result is that, using the current testers and assuming current OSTs, the four-FSL/one-CSL option yields the lowest net cost of the consolidated alternatives and is the only alternative that is cost-competitive with the current decentralized-deployment system. Reducing OSTs would make the four-FSL/one-CSL system less costly than the current system.

Each alternative using the ESTS and current OSTs would be more costly than the current system combined with ESTS. This is because adoption of ESTS in itself produces some of the personnel savings generated by consolidation. With the ESTS, reducing OSTs makes the four-FSL/one-CSL option only slightly more expensive than the current system.

Reducing Equipment and Personnel Deployment Requirements

Quick-hitting expeditionary operations require rapid deployment of combat forces, placing a premium on reducing deployment footprint or on the amount of initial airlift needed to transport support equipment. For a major theater war deployment, all the alternatives we considered would reduce deployment footprint for F-15 avionics maintenance capabilities by up to 60 C-141 or 43 C-17 load equivalents. The ESTS also greatly reduces deployment footprint for the current system, so the alternatives considered would generate a further reduction in deployment footprint of only 12 C-141 or 9 C-17 load equivalents beyond that gained through ESTS.

The current decentralized structure has high and frequent personnel deployment requirements. The consolidated structures would eliminate deployment requirements for some small-scale contingencies and would reduce them for major theater wars. Each consolidated alternative would also be less stressing than those required by the current system in that deployments would be to FSLs rather than to FOLs, which are more likely to be in hostile areas. Of course, the decentralized-no-deployment structure would eliminate deployment personnel requirements.

Personnel retention problems have made it difficult for the Air Force to maintain the required skill-level mix of personnel in areas such as F-15 avionics repair. To solve this problem, the Air Force can either work toward improving the retention of its current personnel or find other sources of repair personnel. The Air Force has attributed its personnel retention problems to frequent deployments to FOLs over the last decade. RAND research on the effects of deployment on personnel retention conceptually supports this contention but also concludes that a low-to-moderate level of deployment, particularly to nonhostile locations such as those in which FSLs would be positioned, has a positive effect on personnel retention.¹ By this standard, a CSL in network with FSLs would be the most favorable alternative for personnel retention, but the elimination of deploy-

¹ See James Hosek and Mark Totten, *Does Perstempo Hurt Reenlistment? The Effect of Long or Hostile Perstempo on Reenlistment*, RAND, MR-990-OSD, 1998.

ments would probably remain preferable to excessive deployments to FOLs in potentially hostile environments. Alternatively, the elimination of deployments to FOLs gives the Air Force flexibility in how it decides to achieve required personnel levels. If the Air Force seeks to find other sources of repair personnel, eliminating deployments or keeping them limited to FSLs would allow for the use of contractors, government-employed civilians, or allied partnerships.

Risks

Decentralized and consolidated structures carry different operational risks. Decentralized deployment is associated with risks in equipment deployment, setup, and downtime. Current planning assumes that the AIS will deploy and be operational by day three of flying operations. Any difficulties encountered in deploying or setting up this complex equipment and in making it fully operational will delay resupply as well. Moreover, if just a single set of testers is deployed to a location—as should be the case when only one squadron deploys to an FOL—then the squadron using those testers faces a “single-string” risk wherein a breakdown of just one tester can halt resupply for an entire group of parts. Resupply shortfalls can result in the decline of aircraft availability below planned levels. “Emergency” setup of an unplanned distribution channel to the FOL could mitigate resupply shortfalls resulting from tester-associated risks.

For both the consolidated and the decentralized-no-deployment alternatives, the need to set up an effective wartime distribution system between repair and operating locations is the major source of risk. Delays in implementation would hinder resupply in much the same manner as would delays in deploying testers under a decentralized-deployment policy. Similarly, any gap between the OST performance assumptions used to plan forward inventory levels and the levels actually achieved would result in a resupply capability unable to support the desired level of aircraft availability. This risk may increase as customs regulations or the remoteness of operating locations increases.

Summary of Alternative Comparisons

The current decentralized-deployment policy, which calls for slightly higher levels of personnel and testers than those in place today, could provide the same level of support at the same cost as, or at a lower cost than, the alternatives examined. However, disadvantages such as personnel instability, deployment foot-

print, and equipment setup and single-string risks have already led many deploying units to modify their procedures on an ad hoc basis.

Modifying the current system to eliminate AIS deployment, as in the decentralized-no-deployment option, eliminates personnel and equipment deployment requirements but requires a one-time increase in spare parts for the supply pipeline. Furthermore, a moderate level of personnel deployment might help improve retention more than if there were no deployment at all.

The four-FSL/one-CSL option is cost-competitive with the current decentralized-deployment option and addresses each of its disadvantages. It offers a moderate level of personnel deployment to nonhostile locations and eliminates equipment deployment and its accompanying risks. These benefits may be offset somewhat by the risk inherent in quickly establishing effective wartime intratheater distribution.

A Test of a Regional F-15 Repair FSL

During Operation Noble Anvil (ONA), the air war against Serbia, the 48th Component Repair Squadron at RAF Lakenheath implemented the FSL repair concept as part of a system of FSLs set up by United States Air Forces in Europe, thereby formalizing practices they had used on an ad hoc basis for several years. Using existing assets and without deploying any AIS personnel or equipment, they were able to successfully support their own aircraft at FOLs as well as concurrent deployments to Southwest Asia. In fact, between October 1998 and March 1999, as tensions rose or eased, the wing supported by this squadron made seven partial-unit deployments back and forth from Lakenheath to Southwest Asia and Italy without moving the AIS (Figure 2). Normally, Air Force policy would require that these deployments include the AIS, but since all of the units were supported from the Lakenheath FSL, no support equipment had to move. As a result, airlift requirements for these seven deployments were reduced by 35 C-141 sorties. More than any theoretical description of the flexibility that FSLs can provide in today's dynamically shifting environment, these operations demonstrated the advantage nondeploying maintenance structures confer in facilitating the repositioning of forces as quickly as political situations change.

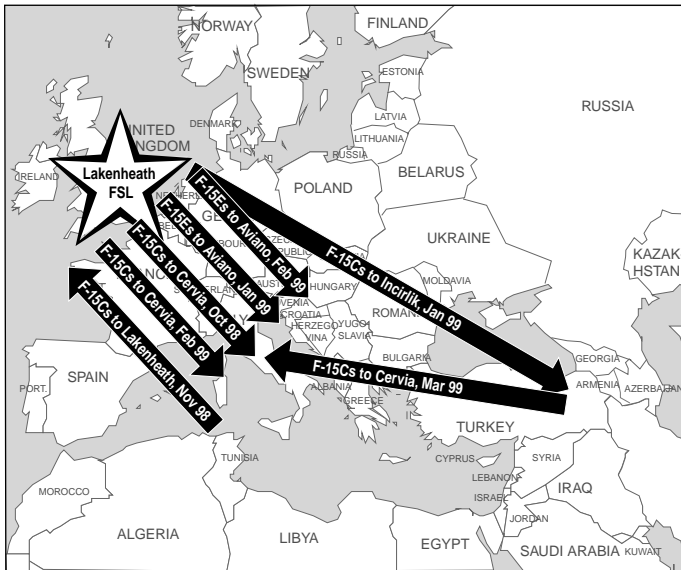


Figure 2—During Operation Noble Anvil, Deployments from Lakenheath to Southwest Asia and Italy Demonstrated the Effectiveness of the FSL Concept

The squadron also implemented plans for the Lakenheath avionics maintenance FSL to support an augmentation of F-15s from CONUS for ONA with just half the deployment footprint and personnel that would have been required had the deploying-wing AIS moved to the new FOL. In a permanent consolidated structure, even this limited equipment deployment would not have been required because the equipment would already have been in place; thus, only personnel would have had to deploy. In exchange for the reduction in deployment airlift, the FSL had to rely on a steady flow of transportation to provide resupply to the operating locations.

Lakenheath logisticians used their prior experience, including that gained in the October 1998 deployment to Cervia, Italy, to conduct transportation planning for providing support from an FSL. This enabled it to provide rapid and responsive resupply of serviceable parts to FOLs from the start of ONA through the intratheater distribution system and a Lakenheath-managed “distribution system” that augmented the joint system. The Lakenheath distribution system was critical to the success of the operation. Other Air Force FSLs established in support of ONA relied solely on the joint intratheater distribution system but did not find that system sufficiently responsive.

Conclusion

The key issue in determining whether to adopt an alternative F-15 avionics support structure seems to lie in the level of risk posed by the need to quickly establish a wartime theater distribution system. The researchers recommend that the Air Force review current plans for wartime theater distribution and then work as part of the joint community to modify them as necessary to address potential performance gaps. Even if the Air Force then elects to continue with the current structure, improving the wartime theater distribution system would reduce equipment risk. Assuming that the Air Force and joint community develop reliable plans for wartime theater distribution, the researchers recommend the adoption of a consolidated network of regional repair locations to reduce deployment burdens and enhance flexibility if the Air Force continues to use the current testers. Such a network would provide more benefits at less cost than ESTS adoption would. However, if the Air Force proceeds with ESTS implementation, the alternative systems would cost more than the current policy and would provide fewer benefits. In this case, the reduced personnel deployment requirements and flexibility provided by the alternative structures should be weighed against their associated spare-parts investment requirements.

MR-1174-AF, *Supporting Expeditionary Aerospace Forces: An Analysis of F-15 Avionics Options*, Eric Peltz, Hyman Shulman, Robert Tripp, Timothy Ramey, John Drew

Supporting LANTIRN in the Expeditionary Aerospace Force

The Expeditionary Aerospace Force (EAF) concept is designed to address several changes in Air Force operational needs. In addition to providing the Air Force with greater flexibility for operations, the EAF concept seeks to reduce personnel “turbulence” while controlling peacetime costs. RAND’s EAF combat support research evaluates how alternative support structures, technologies, and methods affect EAF capabilities.

Nearly all the issues that have led the Air Force to adopt the EAF concept are present in intermediate maintenance operations for Low Altitude Navigation Targeting Infrared for Night (LANTIRN) pods. LANTIRN support easily lends itself to new structures such as consolidation that may improve the effectiveness and efficiency of the EAF support system. Such new repair structures may help the Air Force cut turbulence and provide more stable deployments for LANTIRN support personnel. Research on LANTIRN support issues can also offer insights on dealing with issues relating to aging equipment and technology obsolescence.

The LANTIRN System and Its Components

The LANTIRN system comprises two independently operated pods mounted under the fuselage of an F-15E, F-16C, or F-16D aircraft. The navigation pod enables pilots to fly at low altitudes, even in limited visibility, and thus avoid detection by unfriendly forces. The targeting pod illuminates targets for precision-guided munitions.

LANTIRN pods and their support equipment are based on technology dating from the mid-1980s. Although they are still an essential part of combat operations, LANTIRN pods are becoming obsolete and eventually will be replaced by newer technology. The support technology is increasingly unreliable, and growing obsolescence of spare parts makes it increasingly difficult to repair both pods and test sets. Given current attrition rates, by 2002 there will be fewer targeting pods than LANTIRN-capable aircraft. Nevertheless, the Air Force must maintain a support system for the remaining pods to fully realize their remaining use.

The Air Force currently uses a decentralized structure for LANTIRN maintenance, deploying full sets of testers with LANTIRN-capable aircraft from home

bases to Forward Operating Locations (FOLs). The study team evaluated alternatives to this current structure ranging from using a single Continental United States (CONUS) Support Location (CSL) to using a CSL in network with two to four Forward Support Locations (FSLs).

In addition to these logistics structures, the team evaluated options to upgrade LANTIRN support equipment, including investment in an Advanced Deployment Kit and a Mid-Life Upgrade, which are designed to reduce the deployment footprint and potentially improve support equipment performance and reliability. In fact, the researchers found that without such upgrades the current decentralized structure can no longer meet timeline requirements for expeditionary operations.

Deployment and Transportation Times

Both centralized and decentralized LANTIRN repair operations face critical time constraints. Figure 1 shows the expected targeting pod availability under a decentralized support structure that seeks to provide 80 percent availability, or 0.8 good targeting pods per aircraft operating during the halt phase in a two-major-theater-war (MTW) scenario. In the decentralized structure, the challenge is to deploy and set up equipment within four days of the beginning of combat operations. If deployment and setup take more than one day, then targeting pod

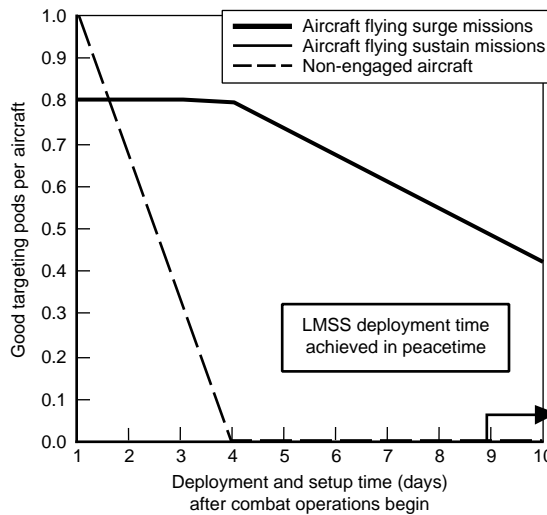


Figure 1—Decentralized Support Targeting Pod Availability During Second MTW

availability for non-engaged aircraft (including aircraft used for training) begins to decrease. If deployment and setup take more than four days, then targeting pod availability for engaged aircraft begins to decrease. Data collected during the air war over Serbia (AWOS) indicate that these deployment and setup times need to be much shorter than the nine to ten days it currently takes to deploy the LANTIRN mobility shelter set (LMSS) under peacetime conditions to ensure pod availability in coincident, large-scale engagements.

In centralized structures, the key performance variable is the time it takes to transport pods between support and operating locations. Figure 2 shows the expected targeting pod availability under a centralized support structure seeking to provide 80 percent availability during the halt phase of a second major theater war. Because centralized support must supply all aircraft worldwide, the figure shows the availability of pods for aircraft flying sustainment operations. For this analysis, the researchers set a pod availability goal of 0.6 good targeting pods per aircraft engaged in sustainment operations. If one-way transportation time exceeds four days, there are no pods available for non-engaged aircraft and targeting pod availability for engaged aircraft begins to decrease. Current CONUS to out-of-CONUS transportation averages seven to ten days, meaning that LANTIRN support cannot rely on a CONUS-only support structure. Data from AWOS indicate that intratheater transportation times, which ranged from three to five days during that contingency, may be able to support a maintenance network comprising FSLs and CSLs. The Air Force also may want to evaluate the goals it has set for pod availability. Aircraft use rates are rarely 100 percent, meaning that lower pod availability goals can be met simply by moving pods from aircraft not being used to those that are.

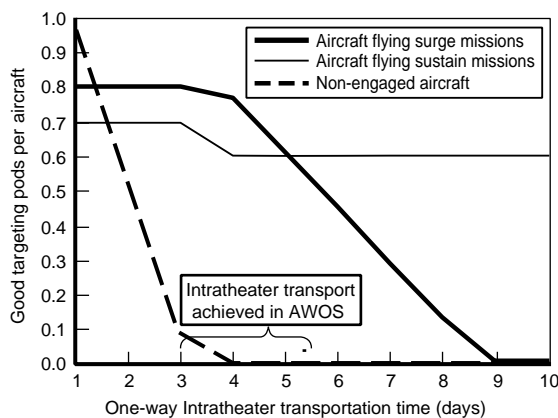


Figure 2—Centralized Support Targeting Pod Availability During Second MTW

Other Support Tradeoffs

Time is the critical variable to consider in designing LANTIRN support structures, but there are several other tradeoffs as well. These include strategic and operational risks, deployment footprint, and organizational issues.

A decentralized support structure is extremely sensitive to airlift availability in the early phase of a mission. Decentralized structures are also sensitive to tester downtime because the failure of just one tester can shut down LANTIRN repair at a decentralized location. EAF goals require a reduction in the deployment footprint, but decentralized repair has a large footprint. For some wartime scenarios, deployment of decentralized LANTIRN support requires the movement of 139 persons and, depending on upgrade investments, up to 341 pallets of support equipment. Equipment upgrades would require fewer pallets for deployment and help decentralized structures to meet performance timeline requirements.

Though extremely sensitive to transportation times, consolidated support overcomes many difficulties that may be posed by the decentralized structure. By collocating testers, consolidated support structures avoid the risk that the breakdown of just one tester can halt repair at a location. Collocation can also increase test string productivity and reduce test set demand. If, for example, the effective demand of one squadron is for three-fourths of a tester, then three centralized testers can serve four squadrons. Consolidated support can considerably reduce the deployment footprint. Under the consolidated LANTIRN support structure, fewer than 50 persons, and no pallets of equipment, are required to move for certain contingency deployments.

Centralized and decentralized structures carry substantially different types of investment and operational costs, but the total recurring costs for centralized and decentralized structures are approximately the same. This minimizes the importance of costs as a criterion for selecting a support structure. More important, analysis of pod failure data during AWOS indicates that the Air Force may not have enough test equipment to support multiple major contingencies. This implies that a very large investment may be needed to ensure the Air Force's ability to meet planned combat scenarios. Another issue for any change may be organizational. Under a consolidated structure, unit commanders will have to relinquish some of their control over LANTIRN pods. They will also have to communicate closely with the support centers and other bases served by the same consolidated facility. Performance metrics and incentive systems may need to change to ensure unit satisfaction, on-time delivery, and quality workmanship.

Conclusions and Recommendations

Although a system relying on a CSL in network with FSLs introduces new transportation time risks, the study team concluded that such a system offers distinct advantages over the current system. The most viable structure would use two FSLs and one CSL, all with the Advanced Deployment Kit upgrade. This option consistently ranks high when all options are considered by performance and risk measures, including pod availability and deployment footprint. Although the underlying premise of the FSL-CSL network is that no equipment moves in support of deployed units, the Advanced Deployment Kit offers additional flexibility to accommodate scenarios that the fixed support structure could not.

During AWOS, the USAF employed some of the centralized repair concepts proposed by RAND research. Fighter aircraft deployed to an FOL in Italy received LANTIRN support from their home base at Lakenheath, UK. No LANTIRN support equipment deployed to the FOL, and pods were transported via multiple modes, thus enabling responsive support. While this limited experience did not fully stress the LANTIRN centralized support system, it provided insights to the potential feasibility of such a system. Based on RAND work prior to the Serbian conflict and the lessons learned from the war, the study team recommends that the benefits and risks associated with LANTIRN repair consolidation be explored further. As a first step, it recommends investment in the Advanced Deployment Kit to ensure continued repair capabilities and improve deployment flexibility.

Both RAND research and the Serbian experience have shown that a transportation system able to respond to a wide variety of scenarios ranging from peacetime to two coincident major theater wars is necessary for successful centralized repair operations. Thus, the team's second recommendation is to reevaluate intratheater transportation system capabilities—starting with the command and control processes used to manage materiel movement. Only after gaining a solid understanding of the transportation system capabilities can the Air Force pursue implementation plans for centralized repair structures.

MR-1225-AF, *Supporting Expeditionary Aerospace Forces: Expanded Analysis of LANTIRN Options*, Amatzia Feinberg, Hyman L. Shulman, Louis Miller, Robert S. Tripp

Acquisition Reform and the Defense Sector: An Assessment of Cost-Savings Claims

Over the past decade, the Department of Defense (DoD) has tried to streamline the process by which it acquires weapon systems. These efforts, collectively known as acquisition reform (AR), have sought to achieve significant cost savings either by restructuring government acquisition processes or by fundamentally altering the relationship between the DoD and its prime contractors. Yet the claims that have been made in the literature regarding the efficacy of these measures have been inconsistent at best and at worst contradictory. Hence, it is difficult to gauge whether any such estimates are sufficiently robust to merit inclusion in future cost models for military combat aircraft.

RAND researchers surveyed a range of AR literature to assess the robustness of both anticipated and actual cost-savings claims made to date, and they developed a taxonomy to group and compare AR initiatives. After reviewing relevant literature on three key initiatives, they concluded that, while published estimates in the literature do not yet support the development of adjustment factors for technical cost models, some rules of thumb can be generated that may be of use to future cost estimators.

Easing the Regulatory and Oversight Burden

The DoD regulatory and oversight cost premium—the additional costs that the DoD is alleged to pay contractors to cover the expense of regulatory compliance—was one of the first areas AR advocates examined in their quest for potential cost savings. In the late 1980s and early 1990s, attempts were made to quantify this premium and to predict the savings that the DoD could potentially derive from regulatory reform. Although lacking in analytical rigor, these early analyses served as the impetus for a variety of more aggressive AR studies, prominent among which was one conducted in 1994 by Coopers & Lybrand (C&L). Commissioned to evaluate the costs of industry compliance with government regulations, C&L found that, on average, the DoD paid an overall regulatory cost premium of approximately 18 percent.

Research conducted in the wake of the C&L analysis produced more conservative estimates. These studies used a wide range of methodologies; however, projections were rarely based on actual post-AR data. Given these limitations, it

is impossible to quantify the cost savings that can be expected to accrue from regulatory and oversight reform. At the same time, nearly all credible estimates made beginning in 1994 appear to fall in the 1 to 6 percent range, yielding an average cost savings—hence a plausible rule-of-thumb estimate—of 3 to 4 percent.

Emulating Commercial Programs to Achieve Cost Savings

Many AR advocates have argued that the greatest potential AR savings may ultimately derive from a group of interrelated measures that, taken in aggregate, aim to model traditional weapon system programs after commercial ventures. The principal goal of these measures is to lower costs by offering contractors incentives that resemble those found in the commercial arena.

The key concept underlying this “commercial-like” approach is cost as an independent variable (CAIV), which requires that cost considerations be accorded a level of priority equal to, if not greater than, that of system performance or schedule. Thus, CAIV requires that both government and industry thoroughly understand a given system’s mission so that mission performance needs can be more effectively weighed against capability requirements.

Proponents of CAIV similarly maintain that, in lieu of supplying detailed technical or design solutions, the government should provide contractors with only those requirements that are integral to the mission. By this means, contractors are given the latitude to develop new technical and design approaches at potentially lower costs. Contractors are also urged to aggressively seek out technologies and parts available in the commercial marketplace in their efforts to meet mission requirements at the lowest possible cost.

Over the past several years, a variety of pilot programs have sought to adapt commercial approaches to military acquisition efforts. The Joint Direct Attack Munition (JDAM), Wind-Corrected Munition Dispenser (WCMD), and Joint Air-to-Surface Standoff Missile (JASSM) “smart” munitions programs, which represent pioneering attempts at regulatory reform, were found to have achieved dramatic gains from their emphasis on CAIV. For example, in all three pilot programs contractors maintained adequate system performance while lowering costs through the exploitation of commercial technologies and parts. Relieved of detailed system specifications, contractors offered an array of cost-benefit tradeoffs and alternative design solutions. The success of these measures was further reinforced by relevant cost data, suggesting that R&D savings in the range of 15 to 35 percent—as well as production savings as high as 65 percent—could be achieved in programs that have been rigorously restructured in accordance with CAIV principles.

However, the reforms carried out in these pilot programs have not been widely used outside AR demonstration programs. Moreover, many AR pilot programs are relatively small and are characterized by low technological risk. Therefore, the scale of potential cost benefits for larger and more complex weapon systems remains uncertain. Finally, the programs evaluated have yet to enter into full-scale production. Hence, neither baseline estimates of pre-AR costs nor post-AR estimates are based on actual product development or production data. As a result, few rules of thumb can be generated for such programs.

Cost Savings Through Multiyear Procurement

In multiyear procurement, the DoD purchases more than one year's supply of a production article through a single contract, thereby allowing for more efficient use of contractors' resources. Multiyear savings have been estimated for a number of programs, including the F-16, C-17, F-22, and F/A-18E/F.

This research suggests that multiyear contracts that are effectively implemented by the prime contractor and government customer can be expected to produce approximately 5 percent or greater savings compared to traditional programs. Multiyear contracts permit long-range planning by contractors. In addition, they permit larger buys of materials and parts, and allow for strategic relationships between primes and subcontractors. Therefore, multiyear contracting should inherently result in some cost savings. However, strategic sourcing relationships between primes, subcontractors, and suppliers fostered under lean manufacturing will have to be evaluated by cost estimators in conjunction with the multiyear savings to ensure that double counting is avoided.¹

MR-1329-AF, *An Overview of Acquisition Reform Cost Savings Estimates*,
Mark A. Lorell, John C. Graser

¹See "Lean Manufacturing and the Defense Industry: Lessons for Cost Analysts" (page 62) for a discussion of strategic supplier relationships.

Lean Manufacturing and the Defense Industry: Lessons for Cost Analysts

Since the end of the Cold War, the Department of Defense (DoD) has launched a number of initiatives whose common objective has been to reduce the costs of weapon systems that are planned, under development, or in production. Largely in response to these measures, U.S. defense firms have in recent years begun to embrace lean manufacturing, a broad collection of principles and practices whose aim is to refashion the production process in a manner that includes the elimination of waste, the removal of inventory buffers, and a focus on quality. To date, however, few studies have been undertaken to determine the extent to which government cost-estimating tools should be appropriately adjusted to reflect the growing use of such practices within the military aircraft industry.

This study assessed U.S. military aircraft manufacturers' use of lean practices with the goal of determining to what extent, if any, the industry's adoption of such practices should be incorporated into government cost-estimating models. After tracing the history of lean manufacturing, the researchers identified the manner in which lean principles have informed each critical phase of military aircraft production. Drawing from a comprehensive survey of the industry, they determined the degree to which manufacturers have adopted lean practices as well as the savings claims from having done so. Although they concluded that it would be premature for the DoD to adjust its cost-estimating tools to reflect projected savings from lean manufacturing, they also suggest an approach in which contractors' claimed savings could influence future aircraft cost estimates.

Lean Manufacturing Principles: An Introduction

Lean manufacturing traces its origins to Toyota's production model, whose tightly coupled and meticulously coordinated manufacturing system was designed to drive closer linkages between all functions within the organization. Central to Toyota's manufacturing philosophy was the maintenance of an extremely low inventory—a practice that in Toyota's view forced attention on eliminating potential problems at their source.

Lean manufacturing has grown to encompass a host of other elements, salient among which is its value-stream focus. This overarching principle holds that manufacturers must first understand virtually every step in a product's evolu-

tion—that is to say, its “value stream”—if they seek to fabricate that product more efficiently. Armed with this knowledge, manufacturers must then search for bottlenecks that may impede the production process and, having done so, must incorporate new tools and techniques into that process as part of a continuous effort to cut costs and improve quality.

Although lean manufacturing holds the potential to significantly reduce costs, it has also been associated with a spectrum of challenges. By its very nature, for example, the lean process hinges on meticulous coordination between all of an organization’s activities and functions. The implementation of lean practices can thus be a difficult and time-consuming endeavor.

Additional problems have been associated with the use of lean processes in an aerospace context. In low-volume industries such as aerospace, for example, parts that may become obsolete must often be purchased at the outset of production—a practice that runs counter to the lean principle of maintaining minimal inventory. In addition, the aerospace industry’s unique relationship with the Department of Defense—its major and often its only customer—has posed problems of its own. The fact that DoD typically establishes the price it pays based on manufacturers’ costs may serve as a disincentive to the implementation of productivity improvements. Nonetheless, the need for efficiency in aircraft manufacture can only increase as post-Cold War military budgets continue to decline.

Lean Practices in the Military Aircraft Industry

Although lean manufacturing is guided by a number of overriding principles, the manner in which these principles are put into practice varies according to function.

Engineering. In many ways, the design engineering function lays the groundwork for lean manufacturing by integrating the perspectives of all relevant participants at the outset of the design process. This integration takes place primarily through the use of integrated product teams (IPTs).

The military aircraft industry has recently made extensive use of IPTs in its efforts to ensure that all key stakeholders in the production process, both internal and external, are given a voice in aircraft design. Despite this widespread use, however, many contractors interviewed questioned the cost-effectiveness of IPTs. Several respondents, for example, expressed the opinion that IPTs involved more initial investment than did traditional design arrangements, primarily because

of the costs of coordinating the greater number of people involved in the design process. Moreover, no data were yet available to support the contention that this initial investment had yielded lower manufacturing costs.

Yet another innovation that has dramatically altered aircraft manufacture is computer-aided design (CAD). By obviating the need for cumbersome mockups and schematics, CAD has greatly facilitated aircraft production, allowing up-front attention to be paid to quality, manufacturability, and cost. As with IPTs, however, not enough aircraft units have been produced by this means to buttress claims of long-term savings. Indeed, preliminary evidence indicates that engineers are not necessarily using CAD tools to design aircraft more quickly but may instead be harnessing these and other technologies to produce better designs in the same amount of time.

Tooling. A number of tooling advances also hold promise of contributing to lean manufacturing. Flexible tools, for example, can be used to fabricate or assemble multiple parts rather than being dedicated to a particular part, thereby removing bottlenecks from the production process. Again, however, scant data were available to corroborate the claim that any savings in cost or time had yet resulted from the use of such tools.

Manufacturing. Lean manufacturing exerts its influence on the factory floor in a number of ways. As with conventional productivity improvements, lean manufacturing practices share an emphasis on cutting costs and minimizing waste. Unlike traditional cost-saving measures, however, such practices advocate that attention be paid both to value-added work, in which a product is machined in accordance with its intended design, and to non-value-added processes, in which a product awaits work or undergoes reconfiguration.

Central to the implementation of lean manufacturing is pull production, a practice that calls for the manufacturing process to begin only when an order from a customer has been received. This approach helps reduce finished-goods inventories while also eliminating waste. Similarly, the lean principle of cellular production focuses on a part or product rather than on a process such as cutting, grinding, or drilling. Within a “cell,” all the machines that work on a particular part are in sequence so that, as soon as one process is finished, the part can be moved to the next operation. Keeping the product moving reduces the amount of inventory stacked up and waiting to be worked on, and it enables earlier identification of quality problems as well. Lean manufacturing also advocates that a range of procedures be adopted on the factory floor, including the use of “shadowboxes” that organize parts or tools in such a way as to make it immediately evident when an item is missing or misplaced.

All the prime contractors that participated in this study reported some experience in the use of lean manufacturing on the factory floor, and many contended that these early efforts had already yielded considerable savings. In a sample of 20 pilot programs, for example, manufacturers reported that the direct labor hours required to produce parts had declined between 5 and 81 percent following the institution of lean practices. Similarly, it was claimed that lean procedures had diminished the cycle time required to produce parts by 13 to 93 percent. Such results offer preliminary evidence that lean principles have the potential to reduce aircraft manufacturing costs. At the same time, however, it is not yet clear whether the savings achieved in these limited efforts can be extrapolated to the implementation of lean principles throughout a manufacturing facility.

Quality Control. The focus on quality is one of the hallmarks of the lean production system. Unlike traditional production methods, however, lean manufacturing seeks to ensure that quality is built in rather than inspected in. Put more precisely, the lean philosophy focuses on finding the root cause of a problem, thereby remedying that problem at its source.

Companies surveyed described quality control policies that had been implemented as part of the lean manufacturing effort. Several firms, for example, claimed that their operator self-inspection programs had resulted in a substantial decrease in the number of quality control personnel. Yet because the costs of quality control are often estimated as a percentage of factory labor or manufacturing costs, the effect of lean implementation on the quality function cannot yet be gauged with any degree of accuracy.

Purchasing. Purchased materials and parts make up a significant portion of the cost of the typical military aircraft, usually comprising some 50 to 70 percent of the cost value stream. Organizations that have adopted lean manufacturing thus attempt to maximize the quality and reduce the costs of purchased parts largely by forging long-term partnerships with key suppliers.

The authors found evidence that all major aerospace companies had programs designed to reduce costs through proactive supplier management. And while respondents' levels of implementation varied, prime contractors interviewed all reported significant success in improving the quality of their purchases. Lean supplier management may thus hold real potential to generate savings, both from reduced material costs and from the production of higher-quality goods. Such savings, however, are contingent on the consistent implementation of lean practices.

Overhead and General and Administrative Costs. Although much of the attention that has been paid to productivity improvement has focused on actual production,

indirect costs such as overhead and general and administrative (G&A) expenses can also be significant drivers of weapon system costs. Accordingly, a number of lean manufacturing initiatives have been designed to help contain such costs. However, respondents' efforts to reduce overhead and G&A were limited in scope and await systematization before significant savings can be realized.

Conclusion: Premature for DoD to Adjust Cost-Estimating Models to Account for Lean Practices

The integration of lean principles into military aircraft production remains in a state of flux. To be sure, nearly all manufacturers surveyed as part of this research had either implemented lean pilot projects or expressed their intention to do so. Moreover, all manufacturers who had initiated such projects reported that savings had already been derived from their efforts. At the time of this research, however, none of the manufacturers surveyed had yet implemented lean manufacturing practices on a broader scale, either from the beginning to the end of the value stream or within the factory as a whole. Hence, it was difficult to assess the accuracy of any of the claims made regarding the effects of lean manufacturing on overall aircraft costs.

Given the dearth of systematic data on the savings that have been achieved from lean manufacturing, no macro adjustments to historical cost-estimating methodologies can yet be made. This is not to say that aircraft manufacturers are not trying to reduce weapon system costs through the application of lean principles; rather, it suggests that factoring these savings into the cost estimates of aircraft systems must await the collection of more comprehensive data. In the interim, the researchers suggest that individual lean initiatives be analyzed and baseline cost estimates discretely adjusted on a case-by-case basis.

MR-1325-AF, *Military Airframe Acquisition Costs: The Effects of Lean Manufacturing*, Cynthia R. Cook, John C. Graser

New Processes for the Estimation of Military Airframe Costs

Since the end of the Cold War, large-scale reductions in defense allocations have prompted both the Department of Defense and Congress to place an increasingly high premium on the affordability of weapon systems. Yet many aircraft contractors and government program managers have long maintained that government cost estimators have consistently overestimated the costs of such systems by virtue of their reliance on outdated forecasting methodologies. The generation of more timely cost-estimating models would thus appear to form the cornerstone of sound acquisition policy.

RAND researchers addressed this issue by updating existing cost-estimating methodologies in the critical area of military airframes. After providing basic background information on the various materials that are used to produce airframe structures, they determined the relative advantages of both traditional and evolving manufacturing techniques. Drawing from an industry survey as well as from part-manufacturing data, they then analyzed how the cost of producing airframe structures varies with material mix, manufacturing technique, and geometric complexity of parts. The data thus derived were then integrated with those from a comprehensive historical cost database to yield a more accurate means of generating airframe cost projections.

Airframe Materials and Manufacturing Processes: An Overview

Although many material properties have a bearing on the production of military airframes, two of the most critical properties are strength and stiffness, especially in relation to weight. Most airframe parts require exceptional strength and stiffness if they are to withstand the loads to which they are subjected during flight. At the same time, low airframe weight boosts aircraft performance in such pivotal areas as range, payload, acceleration, and turn rate.

Advanced composite materials such as carbon-epoxy, carbon-bismaleimide, and carbon-thermoplastic offer precisely these advantages in military airframe applications. Specifically, such composites boast mechanical properties that are comparable to those of metal, including strength and stiffness, but at the same time are of lighter weight. Composites can also be designed and built with more strength and stiffness in some directions than in others, allowing them to be

tailored to the directional loads a part is expected to bear. Finally, composite materials lend themselves to unitization—that is, to the use of one integrated part in place of several smaller parts that must be fastened together into one sub-assembly.

At the same time, composites have also been associated with a host of disadvantages, the most significant of which are higher design, fabrication, and raw material costs. The design flexibility composites afford, for example, carries with it the associated drawback of increased design complexity.

In recent years, however, a number of new composite manufacturing techniques that may offset these deficiencies have come to the fore. The traditional hand layup process, for example—in which workers must manually stack individual layers (plies) on a tool in order to form a composite part—is rapidly being complemented and, in some cases, supplanted by techniques such as automated fiber placement, in which a machine lays down plies, and resin transfer molding, in which parts are formed in a complex die. Both of these technologies make it possible to fabricate highly complex composite parts less expensively and with significantly better tolerances than would be feasible by hand.

New metal manufacturing processes also hold the promise of reducing airframe costs. High-speed machining, for example, has the potential to both lower the cost and increase the complexity of parts that can be fabricated from aluminum. Similarly, hot isostatic-press investment casting has the capacity to greatly enhance the properties of parts cast from titanium. These and other manufacturing techniques must be taken into account if future methodologies are to accurately forecast the manufacturing costs of military airframe structures.

Updating Cost-Estimating Methodologies

In their efforts to generate a more accurate means of estimating military airframe costs, the researchers drew from two primary data sources. First, they surveyed the military airframe industry to obtain estimates of how aircraft production costs varied with airframe structure material mix. Put more precisely, estimates were collected on the relative costs—expressed in labor hours expended per pound of material—of seven different airframe materials broken down into six labor categories. Second, they analyzed actual part-level data from recent aircraft manufacturing efforts to determine the effect of material mix, manufacturing process, and geometric complexity of parts on airframe manufacturing costs. The data thus collected were then integrated with those in a historical cost database to yield an overall methodology for forecasting airframe costs.

In general, the researchers found that the costs associated with manufacturing composite airframe parts remain higher than those associated with comparable metal parts despite the advent of new manufacturing processes and technologies. Estimates drawn from the airframe industry indicated that the labor hours expended in the manufacture of composite parts were consistently higher than those for aluminum across all labor categories examined, often by as much as 60 to 80 percent. At the same time, composite parts were significantly less costly to manufacture than historical data had suggested.

Analysis of part-level data also confirmed that advanced manufacturing techniques require fewer labor hours per pound than do conventional fabrication methods, both for metals and for composites. Indeed, in their analysis of the cost of a notional future fighter aircraft, the researchers found that the application of new manufacturing processes could potentially reduce recurring manufacturing labor hours by as much as 17 percent. These data clearly indicate that airframe manufacturing hours should decrease as modern fabrication techniques are adapted for use within the airframe industry.

Two caveats should be borne in mind in any effort to project future airframe costs. First, a high degree of uncertainty is currently associated with future military aircraft production levels. Every military aircraft program in existence today has generated some degree of controversy in light of post-Cold War decreases in defense expenditures. Thus, the incentive for industry to embrace new manufacturing techniques—and to incur the capital and training costs that such techniques would entail—remains low. Second, as aircraft designs evolve and their performance requirements become more stringent, aircraft structures may require greater complexity, thereby offsetting some of the cost reductions that have been forecast or achieved to date.

This research will provide cost estimators and engineers with a variety of factors that should prove useful in adjusting or creating estimates of airframe costs based on parametric estimating techniques. Cost analysts must, however, remain abreast of changes in industry practice if they are to accurately gauge the potential effects of new processes and materials on future airframe design.

MR-1370-AF, *Military Airframe Costs: The Effects of Advanced Materials and Manufacturing Processes*, Obaid Younossi, Michael Kennedy, John C. Graser

Bundled Services: A Framework for Cutting Costs, Improving Performance, and Supporting Small Businesses

“Bundling” is a fast-growing trend in the commercial sector. The term is applied when services previously purchased separately are consolidated and purchased together from the same provider—e.g., janitorial and building maintenance.

Many commercial organizations have found that bundling cuts their total costs and improves service. These goals are also important to federal organizations. But federal organizations have an additional mandate: by law, they are required to support small businesses. Bundling results in fewer, larger contracts that may be beyond the capabilities of small businesses. To ensure that its procurement procedures meet these diverse goals, the Air Force asked RAND to develop a methodology to (1) decide when and how to bundle the services the Air Force buys and (2) justify these decisions in a way that satisfies the requirements of the 2000 legislation supporting small businesses.

RAND’s suggested methodology is based on review of the applicable literature and extensive interviews with commercial and Air Force buyers, providers of bundled services, and small business advocacy groups. The key to the suggested methodology is a well-constructed Request for Information (RFI) that elicits credible information about potential savings and performance benefits associated with bundling and about small business participation opportunities from the providers themselves. Moreover, the information must be provided in a format that will be useful to the Air Force and justifiable to the Small Business Administration (SBA).

Appropriate Bundling Lowers Costs and Improves Service

The first step in RAND’s research was to understand why and how bundling can be advantageous. The literature review and interviews with commercial firms and Air Force buyers suggest that buyers of bundled services benefit from lower total costs and improved service.

Lower total costs result largely from the use of fewer provider personnel. When one provider offers a variety of related services, it can use its employees more efficiently. Better cross-training, fewer backup personnel, fewer managers, and

process and productivity improvements account for most of the savings. Additional savings can result from increased purchasing power, more efficient use of facilities and capital equipment, and elimination of duplicate information systems and overhead expenses. In addition, Air Force buyers of bundled services may be able to negotiate lower overall profit margins due to increased leverage with providers.

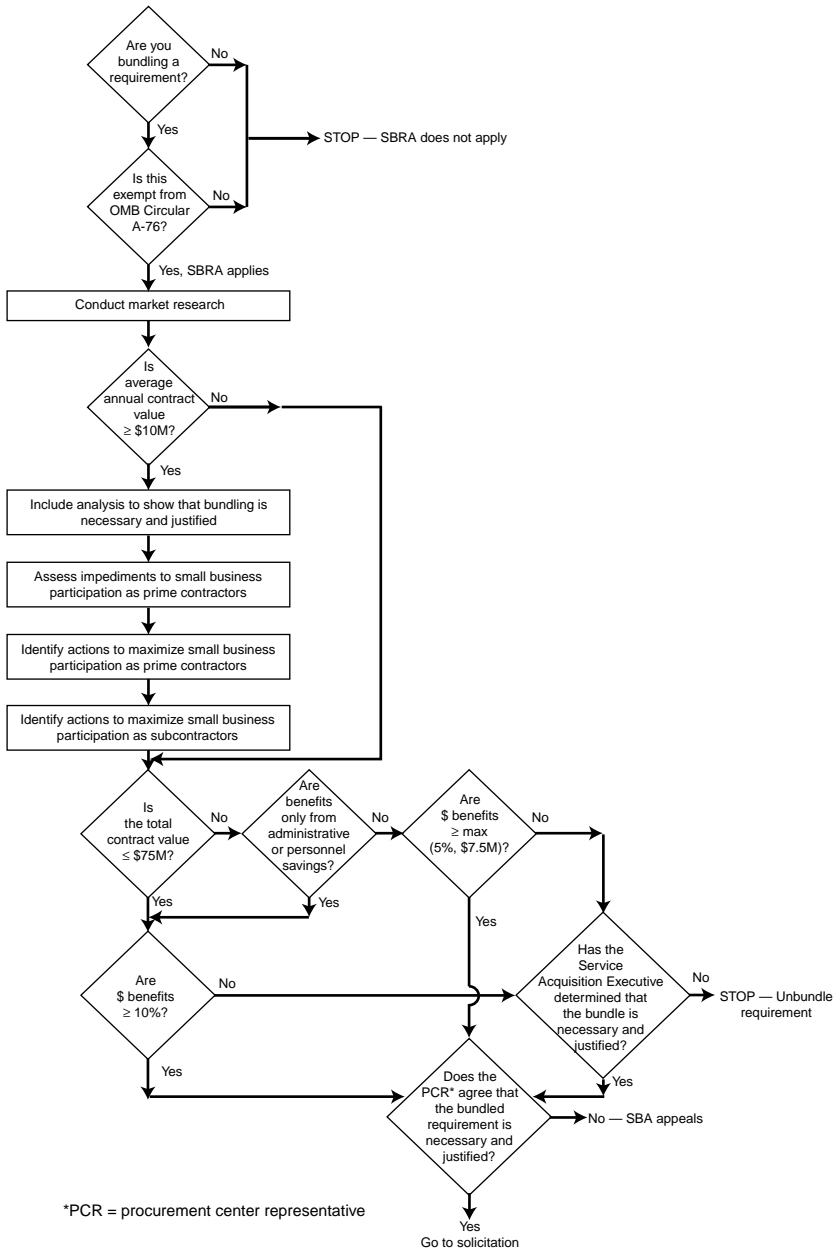
Improved service results from better coordination among related activities, greater emphasis on buyer satisfaction, greater buyer leverage with the provider to improve performance, and greater consistency in service levels. For example, if a toilet overflows, (1) the janitorial staff cleans up the water, (2) plumbers fix the underlying problem, and (3) building and/or groundskeeping staff may be needed to help gain access to hidden or buried pipes. If these services are provided through separate contracts, the buyer must coordinate all work. However, if these services are included in a single contract, the provider is responsible for bringing together all resources in the most efficient manner and fixing the problem to the buyer's satisfaction.

Bundling can offer important benefits, but bundles should not be disproportionately large. Bundling is subject to normal large-organization diseconomies of scale: larger organizations typically have more layers of management, less direct communication among decisionmakers, and more opportunities for divergent interests to emerge. The Air Force should test bundles repeatedly over time to ensure that the benefits continue to outweigh any diseconomies.

RAND's research on commercial firms indicates that bundling is not an easy, one-size-fits-all answer to purchasing decisions. Some settings offer greater opportunities for benefits than others; and the acquisition approach matters. When bundling is appropriate, it is the Air Force buyer's responsibility to construct a bundle that maximizes benefits.

Bundles Must Be Necessary and Justified

The primary legislation addressing bundling is the Small Business Reauthorization Act of 1997 (SBRA), as interpreted by the final rule issued by the SBA on July 26, 2000. (The decision tree shown in the figure outlines the process for complying with SBRA requirements.) SBRA applies to recontracting activities; contracts resulting from Office of Management and Budget (OMB) Circular A-76 studies are exempt. Under SBRA, the buyer must conduct market research to determine whether the bundle is necessary and justified by the resulting benefits. The buyer must also demonstrate that total benefits, including service improvements



Bundling Justification Decision Tree: To Comply with SBRA, Federal Buyers Must Complete Each Step

(stated in terms of dollar savings), exceed the relevant threshold. Furthermore, if the total contract value is \$10 million or more, the buyer must assess impediments to small businesses as prime contractors and identify actions to maximize small business participation as both prime and subcontractors. Finally, the SBA must agree that the bundle is necessary and justified, and it must approve the action plan to protect small businesses. Then the buyer can proceed.

Providers Are the Best Source of Required Information

Providers, particularly leading-edge providers, are the best source of the information the Air Force needs to decide when and how to bundle services and to justify bundling decisions to the SBA. The Air Force, therefore, should construct RFIs in a way that both encourages prospective providers to respond and elicits the quantitative data the Air Force needs. A successful RFI is as easy to answer as possible, gives providers all necessary information, and complies with all regulatory requirements. The Air Force should tailor the RFI to the circumstances of a particular service acquisition as much as possible. Specifically, Air Force buyers should indicate the exact services being considered for bundling, the types of benefits valued by the Air Force, and the level of small business participation the Air Force requires. The RFI should also include baseline information on unbundled contracts, along with clear and simple rules for translating performance benefits into monetary terms. Providers should be asked to specify the types and levels of quantifiable benefits the Air Force can expect.

Evaluating and comparing RFI responses will enable the Air Force buyer to determine if a proposed bundle is appropriate (or if it should be rebundled or unbundled) and, if appropriate, whether it is justifiable to the SBA.

Providers are also the best source of information on small business involvement. Many providers are accustomed to creating opportunities for small businesses. They can suggest appropriate services to subcontract to maximize cost and service benefits. They can also track small business participation throughout the project to ensure that the Air Force's goals for small business participation are met.

Centralization Could Result in Better Acquisition Procedures

The approach developed by RAND places significant demands on Air Force buyers, who must become experts at designing and executing effective RFIs,

evaluating responses, weighing alternative points of view, tracking actual versus estimated benefits, and incorporating lessons learned into future RFIs. Because so many special skills are required, the Air Force could benefit from centralizing its RFI approach. Centralization would allow Air Force buyers to develop a core competency in eliciting and analyzing bundling information. It is also important to recognize that bundling is only one part of acquisition planning. To better coordinate all acquisition activities, market research for bundling decisions should be integrated within the Air Force's broader purchasing and supply management (PSM) and performance-based services acquisition (PBSA) activities.

MR-1224-AF, *Federal Contract Bundling: A Framework for Making and Justifying Decisions for Purchased Services*, Laura H. Baldwin, Frank Camm, Nancy Y. Moore

Drugs and Insurgents in Colombia: A Regional Conundrum

Drug trafficking and political insurgency in Colombia could well confront the United States with the most serious security challenge in the Western Hemisphere since the Central American wars of the 1980s. The second-oldest democracy in Latin America, Colombia is a strategically important country that lies adjacent to Venezuela's oil fields, the Panama Canal, and the Caribbean basin. Colombia's political trajectory will influence the direction of broader trends in the unstable Andean region and beyond.

To date, the United States' response to Colombia's crisis has been limited to the provision of military assistance and technical support to the Colombian government's counternarcotics effort. However, Colombia's narcotics and insurgency problems are so intimately intertwined that dealing effectively with one will almost certainly involve dealing with the other. U.S. policymakers and military planners therefore have a compelling need to gain further insight into the intricacies of Colombia's internal crisis.

RAND researchers addressed this need by examining the sources of Colombian instability and by defining the major players in the country's internal conflicts. The study team outlined the Colombian government's response to its internal crisis as well as the impact of current U.S. assistance programs. They also examined possible scenarios for Colombia's future, assessed their implications for the security of neighboring states and suggested how U.S. policy toward the region might best be redefined.

Colombia's Threefold Challenge

Although Communist guerrilla forces have been active in Colombia since the mid-1960s, it was not until the 1980s that Colombia witnessed an entirely new phenomenon: the linking of an armed Marxist insurgency with the country's ubiquitous drug cartels. This trend began when it became amply evident to Colombia's rebel forces—particularly to its largest guerrilla organization, the Fuerzas Armadas Revolucionarias de Colombia (FARC)—that tapping Colombia's drug-related activities would provide them with the resources they needed to intensify their struggle. Further compounding this problem has been the emergence in Colombia of illegal armed groups known as self-defense forces or para-

militaries. The combined effects of this three-sided civil conflict have severely eroded Colombian society, diminishing the authority of its central government and accelerating its social and economic deterioration.

Over the past decade, the Colombian government has had difficulty containing the guerrillas and has lost control of large areas of the countryside to the FARC. After having suffered particularly devastating defeats at the hands of the FARC from 1996 to 1998, the Colombian military began to adapt and modernize its forces and, as a result, has scored some tactical successes. At the same time, however, the FARC continues to pose a formidable challenge as it pursues military and political objectives.

Colombia's self-defense groups, or paramilitaries, present a different sort of challenge. Although originally formed to protect the populace against Communist insurgents, these groups have in recent years developed alliances with drug-trafficking and other illegal forces. To the extent that they are a product of an environment of insecurity brought about by the state's weakness, the paramilitaries will continue to be a factor in Colombia's crisis. For the Colombian government, however, the dilemma is whether to treat these groups as legitimate political actors or as criminals to be suppressed.

Responding to the Crisis

U.S. policy toward Colombia, which has aimed largely at controlling the country's drug traffickers and producers, has met with only limited success and has at times proved counterproductive. The United States' efforts to attack the "air bridge" linking Bolivian and Peruvian drug cultivators with Colombian refiners, for example, merely prompted the latter to grow their own base material as well as to diversify into opiates. Similarly, the dismantling of the Cali and Medellin cartels in the early 1990s led only to the disaggregation of Colombia's drug trade into several hundred small cartels that now operate in an atomized—and hence a more elusive—fashion. Indeed, the United States' most publicized action against drug producers—its effort to eradicate crops—has not affected coca production, which has in fact risen over the past three years.

Perhaps the most significant shortcoming of the United States' regional policy, however, lies in its focus. Bogota's "Plan Colombia"—a multifaceted response to the country's political and military upheaval—has taken as one of its central goals the reassertion of military authority in areas currently controlled by guerrillas and other nonstate actors. The United States' support for Plan Colombia, however, is predicated on a false distinction between fighting the insurgents and

suppressing the drug trade. Put simply, the current U.S. approach recognizes the nexus between guerrillas and drugs but insists that U.S. military assistance be used only for antinarcotics purposes and not against the guerrillas themselves. U.S. policymakers must decide whether this distinction can be sustained as it becomes increasingly obvious that the war on drugs cannot be won unless the Colombian government regains control of its territory.

Prospects for the Future

Over the past few decades, the Colombian government has made numerous attempts to restore peace by entering into negotiations with guerrilla forces. To date, however, little if any progress has been made on the fundamental issues such negotiations have sought to address. It thus seems unlikely, at least in the near term, that Colombia will regain stability through the forging of a comprehensive peace agreement. Other potential scenarios include a stalemate between the government and the guerrillas or the assertion of the government's primacy over guerrilla and other nonstate forces. The worst-case scenario, however, would involve the outright collapse of the Bogota government and the internationalization of the Colombian conflict. Colombia's neighbors thus fear, with some justification, that they are caught between a hammer and an anvil. They are concerned that aggressive military operations conducted in association with Plan Colombia would drive guerrillas, drug traffickers, and refugees across their borders. Yet they also fear a rebel takeover that could destabilize the entire region.

To address the Colombian crisis more effectively, the United States must develop a proactive strategy that reconciles Colombia's counternarcotics and political-strategic objectives and helps the Colombian government regain control of its territory. An essential part of such a strategy would involve helping Colombia upgrade its armed forces with assistance on the scale needed to redress the currently unfavorable balance of power. The second prong of a proactive U.S. strategy is to work with Colombia's neighbors to prevent spillover and contain the risk of regional destabilization. Only by these means can the United States hope to lift Colombia—and the region as a whole—out of the labyrinth of political instability.

MR-1339-AF, *Colombian Labyrinth: The Synergy of Drugs and Insurgency and Its Implications for Regional Stability*, Angel Rabasa, Peter Chalk

A New U.S. Strategy for a Changing Asia

Under an umbrella of U.S. security guarantees, the past 20 years have been a time of relative peace in Asia and, the 1997–1998 financial crisis notwithstanding, a period of robust economic growth. Currently, however, Asia faces a host of pressures that may well imperil the stability it has recently enjoyed. Asia's very economic success, for example, may ultimately act to its detriment by fueling latent rivalries and ambitions that were once subordinated to economic growth. As a result, long-standing territorial disputes, nuclear rivalries, and nationalist sentiments may come to the fore, thereby disrupting the region's fragile political-military balance.

This study proposes an approach that the United States can take to help preserve stability in Asia in the face of the region's changing security environment. RAND researchers identified ways in which the United States might respond to and shape future Asian developments toward the goal of creating a "dynamic peace." They also examined the long-term implications of this approach for U.S. military forces in general and the U.S. Air Force in particular.

New Regional Challenges

To help ensure Asia's peace and stability, the United States must successfully manage a number of critical regional challenges. In Northeast Asia, for example, improved relations between North and South Korea may culminate in Korean unification or reconciliation, but the resolution of the Korean problem may dramatically alter existing security arrangements and profoundly affect current U.S. force posture. Another key development is China's growing economic, technological, and military prowess. The near-term question for U.S. planners is how best to respond to the threat of Chinese aggression against Taiwan. For the long term, however, the United States must consider the strategic and military challenges China will pose should it seek to diminish U.S. influence in the region or aggressively pursue regional primacy.

India, too, has begun to assume a larger role in regional political-military affairs, and its aspirations to great-power status may become a source of deepening conflict with China. In the interim, India is involved in an ongoing dispute with Pakistan over Kashmir, where incursions, insurgency, and terrorism—coupled with nuclear weapon capabilities on both sides—make for a potentially explo-

sive mix. In Southeast Asia, the fall of the Suharto regime in Indonesia has led to separatist movements and civil strife that may undermine the country's territorial integrity. Japan and Russia aspire to enhanced political and military status that could similarly destabilize the current regional order.

Components of a U.S. Strategy for the Future

To meet such potential challenges, the United States must begin to develop an integrated political, military, and economic strategy aimed at thwarting the growth of rivalries that may engender instability or conflict in the region. Central to this objective is the need to prevent the rise of a dominant power that might seek to undermine the U.S. role in Asia or use force to assert its claims. Of equal importance, however, is the need to maintain stability in the region and to help manage Asia's peaceful development while increasing economic access to the area as a whole.

In the service of these goals, the United States should undertake a four-part strategy:

- Complement its bilateral security alliances to create a broader security framework. This multilateralization could ultimately include Japan, South Korea, Australia, and perhaps Singapore, the Philippines, and Thailand.
- Pursue a balance-of-power strategy among key Asian states that are not part of the U.S. alliance structure, including China, India, and Russia.
- Discourage the use of force as a means of settling territorial disputes.
- Promote an inclusive security dialogue among all the states of Asia as a means of discussing regional conflicts, building confidence, and encouraging states to enter into a multilateral framework in the future.

Implications for the U.S. Military

Implementing such a wide-ranging strategy in Asia will require major adjustments to current U.S. military posture. In particular, the focus of U.S. attention will have to shift from Northeast Asia, which is already well served by the existing U.S. base structure, to other subregions throughout the continent. Although existing security arrangements in Northeast Asia should by no means be abandoned, greater attention will have to be paid to Taiwan, where basing is politically and militarily problematic, and to Southeast Asia, where a permanent U.S.

combat presence is currently lacking. Toward this goal, efforts must be made to assess the feasibility of establishing forward operating locations in Japan to support Taiwan in the event of a conflict with mainland China. Similarly, the United States should seek to solidify existing access arrangements and cement new ones with the Philippines, Indonesia, and possibly Vietnam to prepare for potential military contingencies in Southeast Asia.

Finally, the United States must heed the special challenges South Asia presents. Critical in itself by virtue of the long-standing rivalry between India and Pakistan and the growing nuclear capabilities of each, South Asia is also a vital link between Asia proper and the Middle East and Central Asia. Yet U.S. military forces currently lack reliable access to the subcontinent. Expanding military-to-military relations with former Soviet republics and other Central Asian states could provide valuable access to airspace and facilities in the event that U.S. military resources are needed in this volatile region.

The overall U.S. posture in the Western Pacific would benefit from three additional steps. First, Guam should be built up as a major hub for power projection throughout Asia. Second, the U.S. Air Force and Navy should develop new concepts of operations that would maximize the leverage of their combined forces in a future Pacific crisis. Third, the Air Force should continue to review its future force structure to see if it might benefit from a greater emphasis on longer-range combat platforms.

The United States cannot hope to resolve every regional security issue in Asia, but it can continue to deter aggression and promote peaceful development. To do so effectively, however, it must adopt a comprehensive strategy aimed at preserving U.S. influence in the face of trends that may dramatically alter the region's geopolitical environment.

MR-1315-AF, *The United States and Asia: Toward a New U.S. Strategy and Force Posture*, Zalmay Khalilzad, David T. Orletsky, Jonathan D. Pollack, Kevin Pollpeter, Angel Rabasa, David A. Shlapak, Abram N. Shulsky, Ashley J. Tellis

China's Commercial Technology: Implications for Future Military Capabilities

If China's economy continues to grow as expected over the next 20 years, by 2020 it will surpass that of the United States in terms of purchasing power. Such growth would in theory provide China with the economic base to field a military comparable to that of the United States. But in order to become a true military superpower, China would need to make major improvements in the technological capabilities of its defense industries. One potential source of such improvement could lie in China's civilian industries, many of which currently enjoy unprecedented levels of foreign technology and investment.

This study investigated the degree to which China's commercial sector could contribute to improved military technology over the next 20 years. It found that, while China is likely to narrow the technology gap by 2020, average civilian and military technological levels in China should be expected to remain significantly behind those of the United States and Japan. This failure to "catch up" does not mean that China cannot present a serious military challenge to the United States, however. U.S. policymakers must prepare to address a China whose military technologies continue to advance steadily and one likely to develop strong military capabilities in "niche" areas.

China's Current Technological Capabilities Lag Behind World Standards

The study examined the current capabilities of eight major civilian industries with the potential to support military development: microelectronics, computers, telecommunications, nuclear power, biotechnology, chemical technology, aviation, and space. Among the study's major findings:

China currently has significant production capabilities in all eight areas, and in some of them has facilities that are quite advanced. China's capabilities in producing telecommunications switching systems, fiber-optic cable, and low-end personal computers are comparable to those of advanced industrial nations. China has more than 28,000 chemical-producing enterprises and possesses considerable growth potential in biotechnology. China's space launch capability is

impressive for a developing country, and China has a manned space program that aims to put astronauts in space by 2002.

Despite these successes, China has typically failed to capture the critical technologies associated with these industries, and, as a result, remains largely dependent on imported components and machinery. For example, China lacks the capability to manufacture the lithography tools used to make integrated circuits necessary for microelectronics. China's nuclear facilities have also typically relied on imports for most of their key components. China's aircraft are mostly based on 1950s and 1960s Soviet technology, and China's ability to produce transport aircraft is limited to short-range and medium-range turboprops.

On average, China's technological capabilities are well below world standards. Mediocre or poor performance is typical of many Chinese industries. Manufacturing operations in general tend to be inefficient, while the overall level of computerization in industry is low. China is limited in its ability to produce communications and other types of satellites. Telecommunications firms lack the capability to produce sophisticated terminal node equipment such as cellular phones.

Although China possesses strong basic research capabilities in several areas, it has frequently been unable to translate these successes into improved production technologies. Biotechnology provides a case in point. Despite strong research capabilities, China's commercial biotechnology sector remains small, and future growth in this industry could be impeded by limited production technologies and weak protections for patents. China's software capabilities are just beginning to develop, and piracy remains a major deterrent to domestic software development. Even China's huge chemical industry has typically been unable to turn research results into commercial products, leaving the country dependent on imports for many chemicals.

China's Prospects for Future Technological Progress Are Mixed

The study assesses China's potential for acquiring or developing new technologies in terms of the capabilities provided by facilities, equipment, and human resources; efforts to employ these capabilities to develop new technologies; economic and other incentives; and legal, industrial, and technology institutions.

On the whole, China's prospects for technological progress were found to be mixed. China's physical and human capabilities are substantial but insufficiently developed. The equipment found in most Chinese research and devel-

opment facilities does not meet world standards, while those few facilities that possess advanced equipment do not use it to its full potential. China has a solid educational base for a developing country, but secondary and higher education rates compare poorly with those of more developed countries such as South Korea and Taiwan, and even worse with those of the United States and Japan. The huge size of China's population means that, in absolute terms, China possesses a much larger human capital base for research and development than does South Korea or Taiwan, but the equally huge size of China's workforce means that a greater proportion of scientists and engineers are required for routine production activities. China's technological efforts have also been limited. As a proportion of the total labor force, the number of scientists in China who are engaged in research and development is much lower than that of Taiwan or South Korea, although China surpasses these countries (although not the United States or Japan) in terms of overall research and development expenditures. China's output of scientific and technical publications is much lower than that of the United States and Japan, but significantly greater than that of South Korea and Taiwan.

China's incentive and institutional structures are imperfectly developed. High domestic growth rates and relatively stable exchange rates have tended to encourage innovation. At the same time, uncertainty about the economy, fluctuating inflation rates, limited access to credit and foreign exchange, and periodic instances of political instability have tended to discourage investment in technology. Competition also provides mixed incentives, with many industries overly protected and others subject to excessive fragmentation. Capital markets generally provide poor incentives for innovation, and most bank loans are directed toward government industry, the least technologically dynamic sector. Technology markets are also underdeveloped, although labor markets operate fairly well. China's institutional structures for technological progress, particularly the legal system, are inadequate.

U.S. Defense Planners Must Prepare for a Chinese Military That Is Increasingly Sophisticated

The study concludes that, while Chinese technological capabilities will not catch up to, much less surpass, those of the United States or Japan at any time in the foreseeable future, it is plausible that, by 2020, average technological levels in China might be roughly comparable to those in Taiwan and South Korea today. Moreover, a combination of foreign technology transfer and domestic research efforts could begin to make available to China's defense industries technologies

that are close to those available to U.S. defense industries in some areas. Nonetheless, the process of translating civilian technological capabilities into military technology will be challenging for China.

While China's overall military technology in 2020 can be expected to be significantly inferior to that of the United States, China is likely to develop niche capabilities in certain military technologies. Such capabilities could provide it with a local advantage under certain military scenarios, especially those that would require the U.S. military to operate far from home. U.S. defense planners must prepare for the possibility of conflict with a Chinese military that is increasingly sophisticated, and they should continue to monitor closely China's research and development efforts in order to detect and respond to any particular threats.

MR-1292-AF, *The Military Potential of China's Commercial Technology*,
Roger Cliff

India's Emerging Nuclear Posture

After a hiatus of almost 24 years, India startled the international community by resuming nuclear testing in May 1998. Pakistan responded later the same month with nuclear tests of its own. In the aftermath of these events, many Indian strategic analysts and commentators asserted that New Delhi had been transformed into a consequential “nuclear weapons power,” while the United States and others in the international community increased pressure on India to renounce its nuclear weapons program. An understanding of India’s emerging nuclear posture is crucial to both the United States’ global antiproliferation efforts and its interests in South Asia. This study found that India’s strategic environment, nuclear capabilities, and evolving doctrinal preferences, as well as the technological and organizational tasks facing New Delhi, are far more complex than is commonly acknowledged.

In contrast to the views held by many within and outside India, the study found that New Delhi does not currently possess or seek to build a ready nuclear arsenal. Instead, India’s objective is to create a “force-in-being.” This term refers to a nuclear deterrent that consists of available, but dispersed, components: unassembled nuclear warheads, with their components stored separately under strict civilian control, and dedicated delivery systems kept either in storage or in readiness away from their operational areas—all of which can be brought together as rapidly as required to create a usable deterrent force during a supreme emergency. The implications of such a force for U.S. policy are many. The study concludes that an effective U.S. policy in South Asia must first acknowledge that nuclear rollback is currently not a viable option for India. However, a regional restraint regime of some sort could be sustained if the United States were committed to a deepened engagement with New Delhi and willing to live with a degree of ambiguity about India’s strategic capabilities.

India's Commitment to Maintaining a Nuclear Deterrent

The Indian government’s decision to resume nuclear testing in 1998 resulted from growing pressures for a strategic deterrent in the aftermath of the Cold War. The roots of this decision extend back to the country’s first nuclear test in 1974 which, despite the claims made by India’s scientific establishment then and now, actually produced an insufficient yield, thus ensuring that New Delhi would someday need to resume testing if it sought to maintain an effective nuclear

deterrent. This need became more pressing after a series of events in the late 1980s, including the demise of India's most important protector, the Soviet Union; the newly acquired nuclear capabilities of its traditional antagonist, Pakistan; and the growing economic and military capabilities of its prospective competitor, China. In addition, from New Delhi's perspective, the indefinite extension of the Non-Proliferation Treaty in 1995 and the successful conclusion of the Comprehensive Test Ban Treaty in 1997 increased the costs accruing to India's traditional posture of ambiguity ("keeping its options open") with regard to nuclear weaponry. Ultimately, a new, more risk-acceptant government in India used the opportunity afforded by Pakistan's test firing of the Ghauri—a new missile acquired from North Korea—to resume nuclear testing.

The 1998 tests did not signify a dramatic change in New Delhi's strategic capabilities nor did they signal India's emergence as a potent nuclear weapons power. However, they did symbolize a critical shift in India's strategic direction by committing the country to the active development of a nuclear deterrent force of some kind, a course that is unlikely to be reversed in the future by any succeeding government.

The Force-in-Being: Between “Ready Arsenal” and “Recessed Deterrent”

The study analyzed the viability of five specific nuclear “end-states” that India has debated since its independence in 1947. The two options shown on the left of Figure 1 call for India's denuclearization, either through a renunciation of the nuclear option or the development of regional arms control arrangements with Pakistan and China. The middle position is India's traditional stance of keeping the nuclear option open—neither publicly endorsing nor rejecting the creation of nuclear weaponry. India's 1998 decision to pursue a nuclear posture in the form of a force-in-being is a compromise between the two options on the right end of the spectrum: a ready arsenal and a recessed deterrent. A ready arsenal would involve creating a nuclear force consisting of a sizable inventory of weapons that are maintained in military custody in peacetime and ready for immediate use. In contrast, a recessed deterrent would involve developing various elements needed for an effective deterrent without actually producing a standing nuclear force.

The force-in-being implies that India's nuclear capabilities will be strategically active but operationally dormant, giving New Delhi the capability to execute retaliatory actions within a matter of hours to weeks. Such a capability will allow

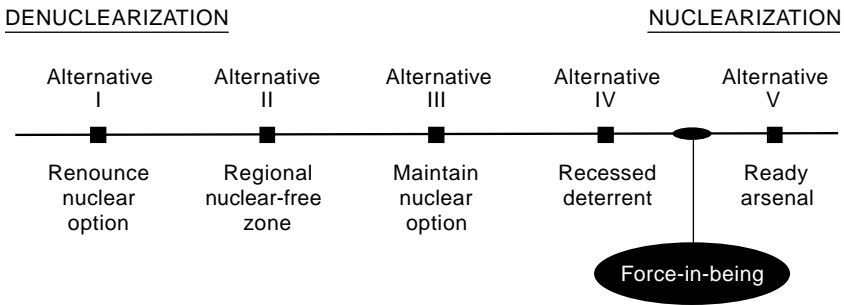


Figure 1—The Spectrum of India’s Nuclear Options and Its Emerging Nuclear Posture

India to gain in security, status, and prestige, while simultaneously exhibiting restraint. India will acquire a nominal deterrence capability against Pakistan and China, while avoiding both the high costs of a ready arsenal and any weakening of its long tradition of strict civilian control over the military.

**India’s Declaratory and Operational Policies:
Nuclear Weapons as Political Tools of Deterrence**

The decision to adopt a force-in-being grew out of a very specific Indian doctrinal conception of the value of nuclear weapons as political tools useful mainly for deterrence rather than defense. This idea is reflected in the main components of India’s strategic policy:

India will adhere to a policy of “no nuclear use” against nonnuclear powers and “no first use” against nuclear adversaries. In effect, this policy implies that Indian nuclear weapons will be used only in response to a nuclear attack on India. India’s commitment to this policy is not likely to change as long as India maintains conventional superiority over Pakistan and China in the theater and does not acquire any extended deterrence obligations in Asia, which it presently does not have and is unlikely to acquire in the future.

In the remote contingency that nuclear use is necessary, Indian nuclear weapons would be most effective in attacks against economic and industrial assets, infrastructure nodes, and population centers (countervalue targets). India’s relatively small number of low-yield weapons are not optimized for effective direct attacks on opposing nuclear forces (counterforce targets), although

they could be used successfully against many military facilities, bases, and field formations in Pakistan and, potentially, against Chinese forces in the Himalayan region (countermilitary targets).

In the event of nuclear attacks on India, the retaliatory use of nuclear weapons will be delayed, but is assured. By definition, a “force-in-being” is not structured for prompt operations. Because Indian security managers feel confident that the possibility of nuclear weapons use in South Asia is remote, they believe that their ability to retaliate with certainty is more important than their ability to retaliate with speed. As India’s strategic capabilities evolve, however, New Delhi will be able to retaliate with both certainty and speed.

The Force-in-Being: Small, Dispersed, Centrally Controlled

India’s emerging force-in-being will not reach its desired form before the end of this decade, but is likely to be characterized by three specific traits.

Modest in size. The future nuclear stockpile could consist of about 150 warheads, depending on the rate at which plutonium and other special materials are produced during the current decade and whether a Fissile Material Control Treaty is successfully concluded during this time. If India resumes nuclear testing with greater success than that exhibited during the May 1998 series, its nuclear arsenal could eventually incorporate both boosted fission and thermonuclear weaponry, although the true reliability and maximum yield of both India’s simple fission weapons and its advanced nuclear designs are uncertain.

The number and configuration of delivery systems incorporated into the force-in-being are also unclear. Over the next two decades, India’s current tactical strike aircraft will be supplemented by an as-yet-undefined number of new rail-, and possibly road-mobile, solid-fueled missile systems or perhaps some kind of sea-based systems over the very long term. Improvements and modifications will also be made to supporting infrastructure; procedural; and command, control, and communication systems.

Separated in disposition and centralized in control. The nuclear force will be routinely maintained in the form of separated components, with the responsibilities for the command, custody, integration, and use of the weapons distributed among civilians and the military, as shown in Figure 2. The command over the use of nuclear weapons will lie solely with civilians in the persons of the prime minister and the cabinet, while civilians and the military will share custody of the strategic assets jointly. In the remote contingency that deterrence breakdown

occurs and nuclear release orders are issued by the prime minister (or his designated successors), the nuclear components would be integrated into a usable weapon system, with custody to be gradually transferred to the military, which would retain sole responsibility for executing nuclear use options. The research also investigated other variations of this command system, which are likely to be used in different strategic circumstances.

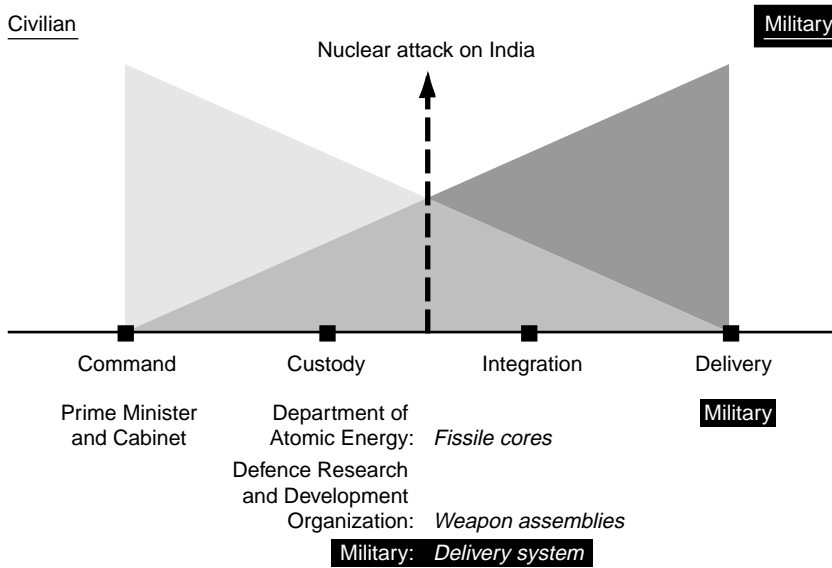


Figure 2—Distribution of Responsibilities for Command, Custody, and Use of Nuclear Weapons

Regional and Global Implications of the Force-in-Being

Although the force-in-being offers many advantages to India, it will not enable New Delhi to cope with all potential regional threats, such as a more aggressive China. Beijing’s current nuclear force is both technologically and numerically superior to India’s. Extensive Chinese attacks could devastate India’s ability to reconstitute its dispersed components, leaving New Delhi with only a ragged retaliatory capability of perhaps little political consequence. Indian security managers are aware of these challenges but not overwhelmed by them, believing that India’s emerging capabilities will allow them to ward off all but the worst contingencies imaginable. Moreover, Chinese nuclear weapon use against India

is believed to be neither likely nor imminent. In the event of a serious prospective Chinese threat, Indian policymakers recognize that their country would not have to face such a contingency alone because an aggressive China would also become a source of concern to great powers like the United States, Japan, and Russia. Finally, India's current nuclear posture does not prevent the country from continuing to improve its strategic capabilities.

One likely result of India's continuing nuclearization will be a weak arms race with Pakistan. The concurrent development of nuclear forces typically leads to such competition, which could be all the more pronounced because of the historical rivalry between the two countries. Many in the Pakistani elite, including the military, believe that New Delhi's strategic capabilities are highly sophisticated and that India is committed to Pakistan's destruction. Such beliefs imply that Pakistan is likely to respond to continued Indian nuclearization with even more intense efforts of its own, which could in turn precipitate Indian counter-reactions. Fortunately, relatively strong economic constraints suggest that the nuclear build-up on both sides will be generally slow.

While India's nuclearization does present complications, it does not represent a failure of the nonproliferation regime. To the contrary, the nonproliferation regime has been a resounding success. It has prevented the worst nuclear threats to international, and particularly to American, security by ensuring that Iran, Iraq, Libya, and North Korea remain bound by international obligations to renounce nuclear weapons. The American architects of the nonproliferation regime recognized from the beginning that India, Pakistan, and Israel would be unlikely to renounce nuclear weapons because all these states are located in areas of high systemic insecurity and, further, because the United States could offer no adequate substitutes for the nuclear option. Other than these three countries, every state in the international system has agreed to accept specific obligations with respect to the acquisition or use of nuclear weaponry.

Policy Recommendations

India's development of a force-in-being represents one stage in the country's slow maturation into a true nuclear weapon power. Coping with such an India remains an important task for U.S. foreign policy. The study makes the following recommendations for U.S. policymakers:

Shift U.S. regional strategy from the prevention of proliferation to the prevention of war. Although Indian policymakers acknowledge that a ready nuclear arsenal is not desirable from the viewpoint of Indian interests, they are strongly

committed to continued nuclear weaponization and missile development. Attempts by the United States to stop this process have little chance of success, but the United States can use its influence to prevent a deterrence breakdown that results in nuclear use.

Work to prevent the diffusion of strategic technologies. The deliberate or inadvertent diffusion of Indian strategic technology to other potential proliferants represents a real threat to U.S. interests that needs to be addressed jointly by Washington and New Delhi.

Shape the character of India's nuclear deterrent by deepened political engagement with New Delhi. The United States cannot provide India with technical assistance to develop its force-in-being, nor should it do so. It can, however, work with India (as well as with Pakistan) to ensure that its evolving deterrent remains modest in size, surreptitious in nature, and slow to be used. Toward that end, the United States should prepare to play three additional roles. First, it should serve as a helpful critic—in private and with due sensitivity to India's security concerns. Second, it should share its own assessments about the character of the strategic environment facing India. Third, it should translate its stated preference for Indo-Pakistani reconciliation over Kashmir into a clear and articulated tenet of its regional policy.

Work with India to develop an overarching strategic vision to guide bilateral U.S.-Indian relations and reconcile the interests of both countries. Such a vision would provide a means for the United States to engage India in a way that supports larger American strategic interests, such as stability in Asia, freedom of navigation in the northern Indian Ocean, coalition arrangements in support of peace operations, and the prevention of further diffusion of weapons of mass destruction.

MR-1127-AF, *India's Emerging Nuclear Posture: Between Recessed Deterrent and Ready Arsenal*, Ashley J. Tellis

Indonesia's Future: Challenges and Implications for Regional Stability

The Republic of Indonesia, the world's fourth most populous and largest Muslim-majority state, is undergoing a profound political transformation. Governmental instability, a fragile economy, secessionist movements, and ethnic and religious conflict threaten the country's nascent democracy. The stakes are high. A successful democratic transition would allow Indonesia to serve as a capable partner in maintaining regional security and stability in Southeast Asia while reducing opportunities for potential Chinese hegemony. Conversely, political deterioration or breakdown, the rise of Islamic radicalism or, in the worst-case scenario, the country's violent disintegration, would likely contribute to a more chaotic and unstable future for the region.

The challenges facing Indonesia and their implications for U.S. policy were the focus of this RAND study. Although the future of the country's democratic evolution will be shaped in large part by domestic and regional factors, influencing this transformation is the most critical foreign policy challenge facing the United States in Southeast Asia. The United States can contribute to a positive outcome in Indonesia by providing support for Indonesia's stability and territorial integrity, building closer military-to-military ties, helping to prevent the further deterioration of Indonesian defense capabilities, and working to restore Indonesia's traditional role as the linchpin of regional stability.

Indonesia's Nascent Democracy Faces Multiple Related Challenges

The researchers analyzed several interlocking challenges that threaten Indonesia's democracy, stability, and territorial integrity.

Economic vulnerability. The economic crisis of 1997–1998 devastated Indonesia's then fast-growing economy. Although there has been a fragile recovery, the economy remains vulnerable, and the underlying causes of the crisis—the large public and private debt overhang and the insolvency of much of the corporate and banking sector—have yet to be resolved.

Political instability. The political transition that began with the first parliamentary election of the post-Suharto era in 1999 and the indirect election of Abdurrahman

Wahid as president marked a milestone in Indonesia's movement toward a democratic political system. However, this transition has been difficult and uncertain. Wahid's government failed to effectively address the country's pressing problems and emerged from its first year in office with a narrowing political base and under imminent threat of removal.

Threats to territorial integrity. The separation of East Timor in 1999 provided an impetus to secessionist movements in the far more economically and politically important provinces of Aceh and Irian Jaya (Papua). At the same time, ethnic and religious violence has escalated in the eastern and central islands, generating stresses that the Indonesian political system may not be able to withstand.

Decentralization. In an effort to mollify the provinces, the central government agreed to a process of decentralization under which both power and revenue would devolve to local jurisdictions. If successful, decentralization could lessen the provinces' distrust of Jakarta and defuse separatist sentiment. But if not properly implemented, the plan could lead to the central government's loss of control of macroeconomic policy, an increase in the disparity between the richer and poorer regions, and an acceleration of separatist tendencies.

Military reform. Indonesia's military is undergoing a significant transformation, which includes a retreat from its institutional political role and the transfer of internal security functions to a newly independent national police force. Implementation of these reforms is far from certain and will require significant resources and enormous changes in the military's organizational structure, training, and personnel practices.

Indonesia's Future Remains Uncertain

The breakdown of Indonesia's old political order has exposed tensions among political forces trying to sort out new power relationships. The study identifies six alternative future scenarios that could result: democratic consolidation, aborted transition and political breakdown, a variant of military rule, a return to authoritarian civilian rule, radical Islamic influence, and territorial disintegration.

Over the short to medium term (one to three years), trends in Indonesia suggest a continuation of weak central government and worsening security conditions in provinces experiencing separatist or communal violence. Over the longer term, barring a lasting upturn in the economy or the conclusion of a workable agreement with disaffected provinces, it is likely that one or more of the downside scenarios will come to pass.

The United States Can Help to Shape Indonesia's Evolution

The overriding challenge for the United States is to help shape Indonesia's evolution so that the country will emerge as a stable democracy and capable partner in maintaining regional security and stability. The United States can begin to move toward this objective by establishing a baseline for engagement with Indonesia, contingent on changing security conditions in Indonesia, Southeast Asia, and the broader Asia-Pacific region. Among the steps the United States should take now are the following:

Support Indonesia's stability and territorial integrity. The United States should work with Japan, other regional allies, and international financial institutions to provide resources to assist Indonesia in overcoming its multiple crises. The United States must be careful not to demand more than the weakened Indonesian government can deliver and should ensure that any giving—or withholding—of aid contributes to the strengthening of Indonesian democratic forces.

Strive to build closer military-to-military ties. The United States can promote a democratic model of military professionalism in Indonesia at a time when the Indonesian military is open to new ideas. The deepening of military-to-military ties could begin with the Indonesian air force and navy, both of which play a major role in linking the island components of Indonesia and generally have not been involved in internal security operations and the human rights abuses reported in that context.

Help restore Indonesia's regional security role. Indonesia is unlikely to resume its leadership role in Southeast Asia until it overcomes its current domestic difficulties. Nonetheless, the United States could move this long-term process forward by helping to restore, to the extent possible, the Indonesian-Australian security relationship, which was damaged as a result of Canberra's involvement in the East Timor crisis of 1999–2000.

A stable, independent East Timor will be key to the rebuilding of Indonesia's role in regional security. Ensuring a constructive relationship between Indonesia and East Timor will require the negotiation of an arrangement that takes into account the interests of all sides, as well as an international effort to train and equip an East Timorese security force capable of securing the border and protecting the population from recalcitrant militia factions.

Support the development of a regional crisis reaction force. The member states of the Association of Southeast Asian Nations (ASEAN) have developed a network of informal bilateral defense ties. The United States could contribute to this process by promoting interoperability and combined exercises with and among

friendly regional states and, if needed, providing supporting capabilities for the effective deployment and operation of an ASEAN military force in a crisis.

The United States and the U.S. Air Force must also plan for contingencies that could arise if the situation in Indonesia were to deteriorate further. Such a plan would require a deepening of defense relationships with and among other friendly regional states, such as Australia, the Philippines, and Singapore. Over the long term, if Indonesia were to overcome its domestic problems, the United States and Indonesia could further develop a cooperative bilateral defense relationship as part of the deepening and widening of the network of U.S. defense arrangements in the Asia-Pacific region.

MR-1344-AF, *Indonesia's Transformation and the Stability of Southeast Asia*,
Angel Rabasa, Peter Chalk

Publications

MR-1127-AF, *India's Emerging Nuclear Posture: Between Recessed Deterrent and Ready Arsenal*, Ashley J. Tellis.

On May 11, 1998, after a hiatus of more than two decades, India conducted a series of nuclear tests that signaled a critical shift in its strategic thinking. Once content to embrace a nuclear posture consisting largely of “maintaining the option”—i.e., neither creating a nuclear arsenal nor renouncing its right to do so—India is now on the threshold of adopting a posture that, while stopping short of creating a ready arsenal, will take as its goal the establishment of a “minimum but credible deterrent,” known as a “force-in-being.” This report examines the forces—political, strategic, technological, and ideational—that led to this dramatic policy shift and describes how New Delhi’s force-in-being will be fashioned, particularly in light of the threat India faces from its two most salient adversaries, China and Pakistan. It evaluates in detail the material, infrastructural, and procedural capabilities India currently possesses as well as those it is likely to acquire in its efforts to meet the needs of its evolving force-in-being. Finally, the volume concludes by assessing the strategic implications of India’s posture both on the South Asian region in particular and on the global nonproliferation regime in general.

MR-1170-AF, *The Role of Southeast Asia in U.S. Strategy Toward China*, Richard Sokolsky, Angel Rabasa, C.R. Neu.

China’s geopolitical ambitions and growing military capabilities and the Southeast Asian states’ perceptions of a “rising China” will play a crucial role in shaping the future of Southeast Asia and the U.S. military posture in the region. The authors examine the role of regional states in developing a hedge against the possible emergence of an overly aggressive China. They find that rather than confronting a conventional attack, the United States and the Southeast Asian countries are likely to find a continuation of China’s creeping irredentism and ambiguous threats. Southeast Asia is likely to prove a critical testing ground for a “third way” of dealing with China’s rising power—what in other RAND work has been called a policy of “conengagement”—that seeks to integrate China into the international system while both deterring and preparing for a possible Chinese challenge. The report recommends that the United States adopt an incremental approach to this hedging strategy, focusing on peacetime military engagement with Southeast Asian states, development of a more robust and diversified network

of access arrangements, and strengthened military ties with the Philippines, Singapore, Thailand, Malaysia, Indonesia, and Vietnam.

MR-1174-AF, *Supporting Expeditionary Aerospace Forces: An Analysis of F-15 Avionics Options*, Eric Peltz, Hyman L. Shulman, Robert S. Tripp, Timothy L. Ramey, John G. Drew.

The goal of the Expeditionary Aerospace Force (EAF) concept is to rely on rapidly deployable, immediately employable, highly effective and flexible air and space packages to flexibly serve the strategic role that a permanent forward presence formerly played in deterring and quickly responding to aggression. Building on earlier analyses that framed a range of general EAF support concepts, this report assesses how well alternative logistics processes and organizational designs for meeting F-15 avionics maintenance demands across the spectrum of EAF operations support this concept. The alternatives range from the current decentralized organization associated with the policy of deploying intermediate-maintenance capabilities with the flying units to consolidated, nondeploying structures. The authors find that consolidating F-15 avionics intermediate maintenance and supporting operations from regional support bases would be more conducive to achieving the EAF goal than the current structure, offering the potential to quickly respond to rapidly changing situations, reduce deployment airlift requirements, and ease the stress that frequent and unpredictable deployments place on maintenance personnel. These benefits would come at the expense of greater reliance on intratheater distribution.

MR-1185-AF, *Strengthening the Partnership: Improving Military Cooperation with Relief Agencies and Allies in Humanitarian Operations*, Daniel Byman, Ian O. Lesser, Bruce Pirnie, Cheryl Benard, Matthew C. Waxman.

Many humanitarian interventions led and supported by the United States go beyond simple disaster relief and include such difficult tasks as protecting refugees, securing humanitarian aid, and restoring civil order. The U.S. Air Force often plays an important role in such complex contingency operations. This report explores how the military might improve coordination with relief agencies and with European allies in such operations. It examines the dynamics of complex contingency operations, provides an overview of the relief community, delineates barriers to better cooperation, discusses the European contribution, and recommends steps the military might take to improve coordination in future crises. Steps include improving military familiarization with key relief organizations—perhaps appointing a humanitarian advisor, establishing more “centers of excellence,” and bringing relief organizations into the planning process. The

military should encourage information sharing with relief organizations, improve procedures for managing the flow of aid, and leverage European capabilities.

MR-1224-AF, *Federal Contract Bundling: A Framework for Making and Justifying Decisions for Purchased Services*, Laura H. Baldwin, Frank Camm, Nancy Y. Moore.

An organization “bundles” the services that it purchases when it consolidates activities previously provided by separate sources and purchases the services through a single contract from a single provider. The Department of Defense is giving increasing attention to this practice because commercial firms report that bundling offers the potential for significant performance and cost benefits. However, the goals of the federal government differ from those of commercial firms in that federal regulations commit the Air Force and other federal organizations to place “a fair proportion” of purchases and contracts with small business enterprises and to maintain free and open competition among prospective providers of services to the federal government. Small businesses typically do not have the scale of operation or scope of expertise to provide bundles of services as prime contractors. The authors of this report discuss recent legislation designed to protect small businesses by ensuring that bundling occurs only when it is likely to generate “measurably substantial” increases in performance or reductions in cost to the federal buyer. After reviewing potential sources of such benefits, the authors propose a methodology that buying agencies could use to gather information on when and how to bundle the services they buy and justify those decisions in a way that satisfies the legislative requirements.

MR-1225-AF, *Supporting Expeditionary Aerospace Forces: Expanded Analysis of LANTIRN Options*, Amatzia Feinberg, Hyman L. Shulman, Louis W. Miller, Robert S. Tripp.

The Low Altitude Navigation and Targeting Infrared for Night (LANTIRN) system consists of two pods (navigation and targeting) employed by F-16s and F-15s. As part of a larger study of support for Expeditionary Aerospace Forces, this analysis addresses logistics structure alternatives for meeting demands for LANTIRN across a spectrum of operational requirements. The study also amends earlier RAND research with new data collected during the air war over Serbia. The authors compare the current decentralized policy, in which intermediate maintenance capabilities are deployed with flying units, with consolidated options in which maintenance capabilities do not deploy. The authors show that consolidating the LANTIRN intermediate maintenance support system may enhance

operational flexibility, improve support responsiveness, and decrease the requirements for highly skilled personnel. However, a regional support structure would be more sensitive to transportation delays and require greater cross-organizational communication. The authors also find that new data suggest that the USAF may not have enough support equipment to meet the requirements of two coincident major theater wars. The decision to centralize or decentralize LAN-TIRN repair operations hinges not on the expected system costs but on the capability and risk levels the Air Force is willing to accommodate.

MR-1235-AF, *Interoperability: A Continuing Challenge in Coalition Air Operations*, Myron Hura, Gary McLeod, Eric Larson, James Schneider, Daniel Gonzales, Dan Norton, Jody Jacobs, Kevin O'Connell, William Little, Richard Mesic, Lewis Jamison.

The United States is increasingly participating in coalition military operations. Coalition support may be required for successful military operations, and in most such operations the United States desires to share the burden. U.S. allies recognize the increased security that coalition operations can bring. Because interoperability is a key element in coalitions, RAND undertook research to help the Air Force identify potential interoperability problems that may arise in coalition air operations and to suggest nonmateriel and technology-based solutions. The research focus is on command, control, communications, intelligence, surveillance, and reconnaissance (C3ISR) systems in out-of-NATO-area operations. The authors' review of recent coalition air operations found that interoperability problems arose because of differences in doctrine, incompatible communications, different planning and execution systems, and different weapon system capabilities. For example, allies may lack sufficient all-weather, day and night, precision-guided weapons. The authors suggest the following to increase interoperability in coalition operations: (1) common or harmonized doctrine for combined joint task force operations, from planning through assessment, (2) compatible or adaptable concepts of operation for airborne surveillance and control, (3) common information-sharing standards and compatible tactical communication systems, and (4) expert, experienced personnel who understand the capabilities of coalition partners. From a technology perspective and cost considerations, C3ISR initiatives appear to offer the best opportunities for interoperability enhancements.

MR-1243-AF, *NATO Enlargement 2000–2015, Determinants and Implications for Defense Planning and Shaping*, Thomas S. Szayna.

In the 1990s, NATO began a course of enlargement and transformation to remain relevant in Europe's post-Cold War security environment. As part of its commit-

ment to enlargement, it admitted three new members—Poland, Hungary, and the Czech Republic—in 1999 and has plans to admit more countries in the future. NATO's enlargement has profound military implications for the United States and its allies in terms of future planning and shaping strategies. Its enlargement and its transformation, from an organization for the collective defense of its members to one whose mission includes conflict prevention and conflict management throughout Europe (including beyond its treaty area), have both been driven primarily by political imperatives—i.e., not by a sense of direct threat, but by an environment-shaping agenda of democratization and integration. This report develops and applies an analytical framework for thinking about the determinants of future NATO enlargement, the specific defense challenges they pose, and shaping policies that might aid in addressing these challenges. The approximately twelve countries that could conceivably join NATO in the next 10 to 15 years are evaluated according to political, strategic, and military (particularly air power) criteria to determine where they stand in relation to NATO's established preconditions for membership consideration and NATO's strategic rationale for issuing invitations to join. The result is a rating of each potential member's relative readiness for and likelihood of acceding to NATO.

MR-1244-AF, *China's Quest for Energy Security*, Erica Strecker Downs.

China's two decades of rapid economic growth have fueled a demand for energy that has outstripped domestic sources of supply. China became a net oil importer in 1993, and the country's dependence on energy imports is expected to continue to grow over the next 20 years, when it is likely to import some 60 percent of its oil and at least 30 percent of its natural gas. China thus is having to abandon its traditional goal of energy self-sufficiency—brought about by a fear of strategic vulnerability—and look abroad for resources. This study looks at the measures that China is taking to achieve energy security and the motivations behind those measures. It considers China's investment in overseas oil exploration and development projects, interest in transnational oil pipelines, plans for a strategic petroleum reserve, expansion of refineries to process crude supplies from the Middle East, development of the natural gas industry, and gradual opening of onshore drilling areas to foreign oil companies. The author concludes that these activities are designed, in part, to reduce the vulnerability of China's energy supply to U.S. power. China's international oil and gas investments, however, are unlikely to bring China the energy security it desires. China is likely to remain reliant on U.S. protection of the sea-lanes that bring the country most of its energy imports.

MR-1245-AF, *Persian Gulf Security: Improving Allied Military Contributions*, Richard Sokolsky, Stuart Johnson, F. Stephen Larrabee (eds.).

Unless America's European allies shoulder more of the responsibility for defending common Western interests both within and outside Europe, NATO's future and America's continuing engagement in Europe could be jeopardized. The challenge facing the United States and its European allies is to forge a broader and more equal U.S.-European strategic partnership that calls for the European allies to participate in joint military operations outside Europe when common Western interests are threatened. Accordingly, this report addresses several key questions: Will America's European allies be able to muster the political will and military capabilities to project significant military force to help defend the Persian Gulf? How much military force can our European allies contribute today and in the future to Persian Gulf contingencies? Under what circumstances can the United States rely on allied force contributions? What are the implications of allied force contributions in the Persian Gulf for U.S. defense planning and force requirements? Can Europe become a more equal partner in defending common Western interests that go beyond peacekeeping and crisis management in Europe? In answering these questions, the authors lay out a practical and realistic blueprint for securing improved European force contributions to Persian Gulf security that appears well within the allies' political, financial, and military means.

MR-1247-AF, *Who Runs What in the Global Information Grid: Ways to Share Local and Global Responsibility*, Martin Libicki.

Traditionally, information provided to warfighters only gave them broad situational awareness. Today, information from sensors and databases can help warfighters target past what they can see. This has prompted the Department of Defense to build a military analog to the Internet, to be a font of warfighting information (and system services). But how should responsibility for providing information and services be shared between global external sources and organic local sources? Both will be necessary, and sensor characteristics matter. But sometimes the need for integrated battlespace pictures (e.g., the Recognized Air Picture) pushes responsibility higher. Thus, tools are needed to let commanders use whatever information from whatever sources fits their needs at a given time. A strong bias toward interoperability would foster universal access to information. Liberal distribution of unit-level sensors and connectivity should help warfighters develop and share operational information. And better technology is needed to marry local and global information sources more easily. Finally, some entity within DoD should review current information services and lay out a road map for filling in the blanks.

MR-1286-AF, *Relating Ranges and Airspace to Air Combat Command Missions and Training*, Albert A. Robbert, Manuel Carrillo, Robert Kerchner, Willard Naslund, William A. Williams.

Ranges and airspace for Air Force training purposes are national resources for which the Air Force must present a credible claim. To help the Air Force articulate its aggregate needs, assess the adequacy of its existing assets, and justify new or existing assets, RAND and Air Combat Command developed an analytic structure containing a joint mission framework, training requirements, infrastructure requirements, and the current infrastructure. RAND also constructed a relational database that can be used to support a variety of staff processes and analyses. The study team found that centralized repositories of information on ranges and airspace are limited, with little provision for updating the data. The range and airspace database partially fills this gap and is a powerful tool for range and airspace managers and a potential tool for other aircrew training resource managers. But it must be maintained and updated, which will require a trained administrator and an understanding of update procedures by managers in the field.

MR-1286/1-AF, *A Decision Support System for Evaluating Ranges and Airspace*, Albert A. Robbert, Manuel Carrillo, Robert Kerchner, William A. Williams.

Ranges and airspace for Air Force training purposes are national resources for which the Air Force must present a credible claim. To help the Air Force articulate its aggregate needs, assess the adequacy of its existing assets, and justify new or existing assets, RAND and Air Combat Command developed an analytic structure containing a joint mission framework, training requirements, infrastructure requirements, and the current infrastructure. RAND also constructed a relational database containing several embedded models that complete parts of the assessment process for range and airspace infrastructure. A graphical user interface (GUI) facilitates user access to the database. Collectively, these elements (a relational database combined with embedded decision models and GUI) constitute a decision support system for range and airspace. To realize the power and potential of the decision support system, a continuing investment must be made in the human capital needed to maintain and operate it. The decision support system could be expanded to include other range and airspace management information, efficient calculation of other training resource requirements, and requirements and infrastructure from non-Air Combat Command range and airspace users.

MR-1292-AF, *The Military Potential of China's Commercial Technology*, Roger Cliff.

China's economy is expected to grow over the next 20 years at a rate that will make it larger than the U.S. economy at the end of that period. This suggests that China has the economic potential to be a U.S. military rival by the year 2020. But can it become such a rival? At present, China's military hardware is largely based on 1950s Soviet technology. To produce weaponry technologically comparable to U.S. weaponry by 2020, China would have to improve its technological capabilities through internal, defense-industry efforts and/or other avenues: direct transfers of military technology from abroad, imports of components and equipment, and diffusion from China's civilian industries. Of these three, the third, diffusion from civilian industries, is the most promising over the long run. This report explores this option, examining China's current commercial technology in eight industries (microelectronics, computers, telecommunications equipment, nuclear power, biotechnology, chemicals, aviation, and space) that have the most potential for supporting military technology development, and assessing the prospects for technological progress (in terms of capabilities, effort, incentives, and institutions) over the next 10 to 20 years. The findings suggest that even though China's military will not be the U.S. military's technological equal by 2020, the United States still must prepare for a Chinese military whose capabilities will steadily advance in the next 10 to 20 years, perhaps developing competencies in certain "niches" that will present difficulties for the U.S. military in some potential-conflict scenarios.

MR-1315-AF, *The United States and Asia: Toward a New U.S. Strategy and Force Structure*, Zalmay Khalilzad, David T. Orletsky, Jonathan D. Pollack, Kevin Pollpeter, Angel M. Rabasa, David A. Shlapak, Abram N. Shulsky, Ashley J. Tellis.

The past 20 years have been a time of relative peace in Asia and, notwithstanding the 1997–1998 financial crisis, a period of robust economic growth as well. Currently, however, Asia is beset by a variety of problems—including territorial disputes, nuclear rivalry, rising nationalist sentiments, and increased military capabilities—that could well imperil the stability it has long enjoyed. This report summarizes the manner in which the United States can best meet these challenges and thereby ensure continued peace and stability in the region. In the interests of this goal, the report outlines an integrated political, military, and economic strategy that the United States can pursue to inhibit the growth of rivalries in Asia and, more broadly, prevent the rise of instability in the region. Also delineated are changes in U.S. military posture that will be made necessary by this strategy.

MR-1325-AF, *Military Airframe Acquisition Costs: The Effects of Lean Manufacturing*, Cynthia R. Cook, John C. Graser.

During the past couple of decades, many segments of U.S. industry have benefited from introducing new manufacturing techniques that save money by increasing efficiency and reducing overhead. Would U.S. military aircraft manufacturing benefit from these techniques as well? This report examines the package of new tools and techniques known as “lean production” to see if it would enable aircraft manufacturers to produce new weapon systems at costs below those predicted by historical cost estimating models. The authors give a broad overview of what “lean” is and what it can and cannot accomplish in cutting manufacturing costs. They also detail results of industry efforts in this regard, including specific examples and averages of claimed cost savings. The authors conclude by identifying areas where companies need to push harder in lean implementation and what the Defense Department can do to encourage this.

MR-1329-AF, *An Overview of Acquisition Reform Cost Savings Estimates*, Mark A. Lorell, John C. Graser.

A number of analyses have recently been conducted in efforts to update technical cost models and cost estimating relationships for fixed-wing combat aircraft, particularly in light of the numerous cost-saving measures that have been initiated over the past decade. This report focuses specifically on acquisition reform (AR), or the institution of changes either in government acquisition processes or in the relationship between the government and Department of Defense (DoD) “primes.” Its objective is to study relevant literature and conduct interviews with government and industry officials to determine whether estimates made on the efficacy of AR measures are sufficiently robust to be of predictive value. The literature examined covered three types of AR reform measures: reductions in DoD regulation and oversight compliance; pilot programs seeking to emulate commercial efforts; and multiyear procurements. Interviews were conducted with a wide variety of government officials responsible for acquisition policy and operations as well as available industry personnel. The report concludes that there is insufficient evidence in the current literature to support the development of accurate adjustment factors for use in predictive cost models for military combat aircraft. It also suggests, however, that at least in some categories of AR, “rules of thumb” for potential AR cost savings can be developed that may be of some use in limited circumstances.

MR-1339-AF, *Colombian Labyrinth: The Synergy of Drugs and Insurgency and Its Implications for Regional Stability*, Angel Rabasa, Peter Chalk.

U.S. policy toward Colombia has been driven to a large extent by counter-narcotics considerations, but the evolving situation in that South American country confronts the United States with as much of a national security as a drug policy problem. Colombia is a strategically important country whose trajectory will influence broader trends in the Andean region and beyond. *Colombian Labyrinth* examines the sources of instability in the country; the objectives, strategy, strengths, and weaknesses of the government, guerrillas, and paramilitaries and the balances among them; and the effects of the current U.S. assistance program. Possible scenarios and futures for Colombia are laid out, with implications for both the United States and neighboring countries. The authors find that instability in Colombia stems from the interaction and synergies of the underground drug economy and armed challenges to the state's authority. Solutions to the core problem—the weakness of the Colombian state—must focus on resolving the broader set of political-military challenges that result from the convergence of drug trafficking and insurgency. The authors recommend that Colombia's military and institutional capabilities be improved to enable the Colombian government to regain control of the countryside and that, at the same time, the United States work with Colombia's neighbors to contain the risk of spillover and regional destabilization.

MR-1344-AF, *Indonesia's Transformation and the Stability of Southeast Asia*, Angel Rabasa, Peter Chalk.

Indonesia, the world's fourth most populous country, is undergoing a profound transformation that could lead to a variety of outcomes, from the consolidation of democracy to return to authoritarianism or military rule, to radical Islamic rule, or to violent disintegration. The stakes are high, for Indonesia is the key to Southeast Asian security. The authors examine the trends and dynamics that are driving Indonesia's transformation, outline possible strategic futures and their implications for regional stability, and identify options the United States might pursue in the critical challenge of influencing Indonesia's future course. Steps the United States might take now include support for Indonesia's stability and territorial integrity, reestablishment of Indonesian-U.S. military cooperation and interaction, aid in rebuilding a constructive Indonesian role in regional security, and support for development of a regional crisis reaction force. A continued strong U.S. presence in the Asia-Pacific region will reinforce the U.S. role as regional balancer.

MR-1351-AF, *The Conflict Over Kosovo: Why Milosevic Decided to Settle When He Did*, Stephen T. Hosmer.

This report examines the reasons Slobodan Milosevic, then president of the Federal Republic of Yugoslavia, decided on June 3, 1999, to accept NATO's conditions for terminating the conflict over Kosovo. Drawing upon the testimony of Milosevic and other senior Serb and foreign officials who directly interacted with Milosevic, the report analyzes (1) the assumptions and other calculations that underlay Milosevic's initial decision to defy NATO's demands with regard to Kosovo, and (2) the political, economic, and military developments and pressures, and the resulting expectations and concerns that most importantly influenced his subsequent decision to come to terms. While several interrelated factors, including Moscow's eventual endorsement of NATO's terms, helped shape Milosevic's decision to yield, it was the cumulative effect of NATO air power that proved most decisive. The allied bombing of Serbia's infrastructure targets, as it intensified, stimulated a growing interest among both the Serbian public and Belgrade officials to end the conflict. Milosevic's belief that the bombing that would follow a rejection of NATO's June 2 peace terms would be massively destructive and threatening to his continued rule made a settlement seem imperative. Also examined are some implications for future U.S. and allied military capabilities and operations.

MR-1353-AF, *Evaluating Possible Airfield Deployment Options: Middle East Contingencies*, William D. O'Malley.

In the interests of preserving economic stability, the United States is likely to continue in its role as guardian of global access to energy supplies in the Middle East. Ultimately, however, the success of U.S. strategy in this region will pivot on ready military access to bases and other facilities throughout the area. Yet given the volatility that has long characterized the region, together with ongoing military and political changes there, U.S. planners can no longer rely on timely or unconstrained access to such facilities. The United States and its allies thus have a compelling need for a broader range of potential deployment options in the region. Accordingly, this report examines the operational capabilities of commercial and military airfields throughout the Middle East and the Black and Caspian Sea regions. Evaluated in this context were the distance of various airfields from projected missile threats, the effect of such distance on combat sortie rate, the ability of various bases to sustain high-tempo combat operations, and the presence of requisite support infrastructure. The report concludes with recommendations on which bases in these areas best meet the current and anticipated operational requirements of U.S. and coalition forces.

MR-1365-AF, *NATO's Air War for Kosovo: A Strategic and Operational Assessment*, Benjamin S. Lambeth.

This report offers a thorough appraisal of Operation Allied Force, NATO's 78-day air war to compel the president of Yugoslavia, Slobodan Milosevic, to end his campaign of "ethnic cleansing" in Kosovo. The author sheds light both on the operation's strengths and on its most salient weaknesses. He outlines the key highlights of the air war and examines the various factors that interacted to induce Milosevic to capitulate when he did. He then explores air power's most critical accomplishments in Operation Allied Force as well as the problems that hindered the operation both in its planning and in its execution. Finally, he assesses Operation Allied Force from a political and strategic perspective, calling attention to those issues that are likely to have the greatest bearing on future military policymaking. The report concludes that the air war, although by no means the only factor responsible for the allies' victory, certainly set the stage for Milosevic's surrender by making it clear that he had little to gain by holding out. It concludes that in the end, Operation Allied Force's most noteworthy distinction may lie in the fact that the allies prevailed despite the myriad impediments they faced.

MR-1370-AF, *Military Airframe Costs: The Effects of Advanced Materials and Manufacturing Processes*, Obaid Younossi, Michael Kennedy, John C. Graser.

In recent years, a number of attempts have been made to estimate the cost of future weapon systems toward the goal of optimizing acquisition policy. This report focuses specifically on the effects of material mix, manufacturing techniques, and geometric complexity of parts on the cost of military airframes. It begins by offering background information on those materials that are most critical to airframe manufacture and on the relative advantages of both traditional and evolving part fabrication techniques. It then proceeds to a quantitative analysis of the cost implications of various materials and manufacturing techniques on airframe production, drawing both from an industry survey and from analysis of industry data. The data thus derived are then integrated with those of a comprehensive historical database. The report concludes that composites, while offering a number of advantages over metals in airframe manufacture, are generally associated with higher costs across a range of categories. At the same time, it concludes that while new manufacturing technologies hold the potential to diminish airframe manufacturing costs, the increased airframe complexity of future fighter aircraft may well offset this advantage. The report recommends that cost analysts remain abreast of changes in industry practice so that they may more accurately gauge the potential effects of such changes on future airframe costs.

MR-1385-AF, *Operations Against Enemy Leaders*, Stephen T. Hosmer.

Operations targeted against senior enemy leaders have long been viewed as a potential means of shaping the policy and behavior of enemy states. As a result, the United States has launched a variety of overt and covert operations in efforts to attack enemy leaders directly, facilitate their overthrow by coup or rebellion, or secure their ouster through external invasion. This report examines a number of leadership attacks from World War II to the present to offer insights into the comparative efficacy of various forms of leadership attacks, their potential coercive and deterrent value, and the possible unintended consequences of their ill-considered use. It concludes that direct attacks, coups, and rebellions have met with only limited success and, even when successful, have sometimes yielded counterproductive results. Moreover, neither direct attacks nor coups have been of significant coercive or deterrent value, although rebellions have at times provided useful negotiating leverage. By contrast, external invasions have proved to be more efficacious both in shaping the targeted countries' policy and behavior and in exerting coercive effects. The report concludes by outlining the likely conditions under which future leadership attacks are likely to be sanctioned and delineating the prerequisites of effective use of air power in such contexts.

MR-1387-AF, *Defense Planning in a Decade of Change: Lessons from the Base Force, Bottom-Up Review, and Quadrennial Defense Review*, Eric V. Larson, David T. Orletsky, Kristin Leuschner.

The end of the Cold War ushered in an era of profound change in the defense policymaking environment. Yet the changes in strategy, forces, and resources that have characterized the post-Cold War era often proceeded at different paces and have at times moved in opposing directions, placing unprecedented strain both on the policymakers who sought to shape a new defense strategy, and on the forces that were to execute this strategy. This report describes the challenges policymakers faced as seen through the lens of the three major force structure reviews that took place over the last decade: the 1989–1990 Base Force, the 1993 Bottom-Up Review, and the 1997 Quadrennial Defense Review. The report describes the assumptions, decisions, and implementation of each review, as well the emergence of problems regarding modernization, readiness, and risk in executing the national military strategy. It concludes that all three reviews fell short of fully anticipating the budgets that would be needed or afforded. The result was a growing imbalance between strategy, forces, and resources over the decade that widened until the last two years, when defense budgets saw their first real increases in a decade.

MR-1391-AF, *European Contributions to Operation Allied Force: Implications for Transatlantic Cooperation*, John E. Peters, Stuart Johnson, Nora Bensahel, Timothy Liston, Traci Williams.

Operation Allied Force, the 1999 NATO air campaign that sought to prevent a wider humanitarian disaster in Kosovo, represents the triumph of air power to some observers and highlights air power's limitations for others. While representing a successful cooperative allied military action for NATO, it also suggests limits to U.S.-European military cooperation. This report, a dispassionate assessment of Operation Allied Force, provides perspectives from both sides of the Atlantic as well as political and military implications. The campaign highlighted the growing gap between U.S. military capabilities and those of Europe, the potential consequences of joining a limited-objective operation that expands to undesirable proportions and duration, the absence of consensus both within the U.S. military and the Alliance on the best use of air power, the vulnerabilities of a multimember military coalition engaged in an essentially humanitarian operation facing an adversary fighting for its survival, and the limitations inherent in a "fight-and-negotiate" strategy that left an unrepentant adversary in power. The report concludes that the European allies can expect continued emphasis on the Defense Capabilities Initiative, a U.S. plan adopted by NATO that stresses the need for all NATO forces to be interoperable, deployable, and sustainable. Furthermore, the Europeans must reverse recent trends of defense reductions and invest more in order to realize major improvements in defense capabilities.

MR-1398-AF, *Aerospace Operations Against Elusive Ground Targets*, Alan Vick, Richard Moore, Bruce Pirnie, John Stillion.

In response to air power's growing ability to detect and defeat large ground forces in the open, enemy forces are becoming increasingly elusive, operating in smaller formations and using civilian motor traffic, built-up areas, and woods to hide their forces and activities. To help the United States Air Force (USAF) better understand and prepare for a world in which such targets predominate, this study seeks to identify concepts and technologies that could improve the USAF's capability to detect, classify, recognize, and defeat elusive targets, whether dispersed ground forces or mobile ballistic missiles.

Emphasized is an integrated system of technologies, focused analysis, and streamlined control procedures that will enable the detect-classify-recognize-defeat cycle to occur in minutes rather than hours or days. Although new technologies (e.g., improved sensors, small unmanned aerial vehicles, hypersonic weapons, automatic target recognition software) are necessary, they alone cannot solve this

problem. Rather, it is the combination of pre-battle analysis, new technologies, and streamlined control that offers the potential to dramatically improve U.S. capabilities against elusive targets.

This report presents engagement concepts that bring together finders (assets required to identify and track enemy forces as well as civilians who might be put at risk); controllers (who direct the actions of finders and strike aircraft, select worthwhile targets, and make decisions to engage); and strike assets (ground-to-ground or air-to-ground weapons used to attack the targets). Each concept for detecting and defeating elusive maneuver forces and mobile missiles focuses on attacking enemy vehicles rather than personnel to capitalize on unique signatures that can be detected by clusters of, for example, acoustic, seismic, and imaging sensors, or an integrated system of synthetic aperture, inverse synthetic aperture, and ground moving-target indicator radars.

MR-1408-AF, *Special Operations Forces and Elusive Enemy Ground Targets: Lessons from Vietnam and the Persian Gulf War*, William Rosenau.

In the Vietnam War and the Persian Gulf conflict, special operations forces (SOF) conducted reconnaissance operations to locate hidden targets when political and other considerations prevented the deployment of conventional ground units and air power alone was unable to locate and eliminate elusive objectives. In Vietnam, SOF teams crossed the border into Laos to search for truck parks, storage depots, and other assets along the Ho Chi Minh Trail that were obscured by jungle canopy and camouflage. In western Iraq, British and American SOF patrolled vast areas searching for mobile Scud launchers. In both cases, the nature of the terrain combined with adversary countermeasures made it extremely difficult for ground teams to achieve their objectives. There are a number of implications for future operations. Although new technology, such as mini- and micro-unmanned aerial vehicles, may make it easier for teams to reconnoiter wide areas, using SOF in this fashion is unlikely to achieve U.S. objectives. Concerns about casualties and prisoners of war are likely to limit the use of SOF to the most vital national interests. However, unattended ground sensors could play an enhanced role in future operations. Although most will be delivered by air, some will require hand emplacement in difficult enemy terrain, a mission well suited to SOF. SOF in a battle damage assessment role could help ensure that critical targets have been destroyed. Finally, SOF might disable, destroy, or recover nuclear, biological, or chemical weapons.

Administration

USAF Project AIR FORCE Steering Group

General Robert H. Foglesong (Chairman), *Vice Chief of Staff*

General (Sel) Lance W. Lord, *Assistant Vice Chief of Staff*

Lieutenant General Charles F. Wald, *Deputy Chief of Staff,
Air and Space Operations*

Lieutenant General John L. Woodward, Jr., *Deputy Chief of Staff,
Communications and Information; and Deputy Chief Information Officer*

Lieutenant General Stephen B. Plummer, *Principal Deputy Assistant
Secretary of the Air Force for Acquisition*

Lieutenant General Joseph H. Wehrle, Jr., *Deputy Chief of Staff,
Plans and Programs*

Lieutenant General Michael E. Zettler, *Deputy Chief of Staff,
Installations and Logistics*

Lieutenant General Richard E. Brown, *Deputy Chief of Staff, Personnel*

Major General Ronald J. Bath (Executive Agent), *Director of Strategic Planning,
Office of the Deputy Chief of Staff, Plans and Programs*

February 2002

Project AIR FORCE Management

Natalie W. Crawford, Vice President and Director

Alan J. Vick, Associate Director

Donald V. Palmer, Director of Operations, Air Staff Liaison

Judith A. Larson, Director of Communications

William W. Taylor, Liaison, Air Combat Command, Langley AFB

Program Directors

Tim Bonds, Aerospace Force Development
Michael Kennedy, Associate Program Director

S. Craig Moore, Manpower, Personnel, and Training
Al Robbert, Associate Program Director

C. Robert Roll, Jr., Resource Management
Laura Baldwin, Associate Program Director

Edward R. (Ted) Harshberger, Strategy and Doctrine
David Shlapak, Associate Program Director

Air Force Fellows at RAND

Project AIR FORCE benefits from the participation of Air Force officers who serve as research fellows within PAF and RAND, a tradition for nearly 50 years. In 2001, the following Air Force officers, representing several Air Staff organizations, contributed their expertise to PAF research projects:

Lieutenant Colonel Virginia Wereszynski, Office of the Air Force
Surgeon General

Lieutenant Colonel Jeffrey Yuen, Air Force Space Command

Lieutenant Colonel Scott Gibson, Directorate of Intelligence,
Surveillance, and Reconnaissance

Lieutenant Colonel Marc Dippold, Office of the Deputy Chief of Staff,
Air and Space Operations

Lynne Leftwich, Air Force Civilian Fellow

Lieutenant Colonel Constance Davis, Office of the Deputy Chief
of Staff, Personnel

Lieutenant Colonel David Johansen, Office of the Deputy Chief of Staff,
Installations and Logistics

In addition, PAF has one full-time Air Force service member who provides administrative, classification, and authentication support:

Master Sergeant Herman L. Dishman, Directorate of Strategic Planning

RAND Organization

CORPORATE OFFICERS

James A. Thomson, *President and Chief Executive Officer*

Michael D. Rich, *Executive Vice President*

Richard Fallon, *Vice President and Chief Financial Officer*

Robert H. Brook, *Vice President and Director, RAND Health*

Natalie W. Crawford, *Vice President and Director, Project AIR FORCE*

Thomas McNaugher, *Vice President and Director, Arroyo Center*

Jeffrey Isaacson, *Vice President and Director, National Security Research Division
(National Defense Research Institute)*

Adele R. Palmer, *Vice President, Human Resources, Research Staff
Management Department*

Bruce Hoffman, *Vice President and Director, Office of External Affairs*

RESEARCH UNITS

ARROYO CENTER (Army Research Division)

Thomas McNaugher, *Vice President and Director*

COUNCIL FOR AID TO EDUCATION

Roger Benjamin, *President*

RAND CRIMINAL JUSTICE

Jack Riley, *Director*

RAND INSTITUTE FOR CIVIL JUSTICE

Robert Reville, *Acting Director*

LABOR AND POPULATION PROGRAM

Lynn A. Karoly, *Director*

NATIONAL SECURITY RESEARCH DIVISION

(National Defense Research Institute)

Jeffrey Isaacson, *Vice President and Director*

PROJECT AIR FORCE

Natalie W. Crawford, *Vice President and Director*

RAND EDUCATION

Dominic J. Brewer, *Director*

RAND ENTERPRISE ANALYSIS

Richard Hillestad, Richard Neu, James Quinlivan, *Directors*

RAND EUROPE

David C. Gompert, *President*

RAND HEALTH

Robert H. Brook, *Vice President and Director*

SCIENCE AND TECHNOLOGY PROGRAM

Stephen Rattien, *Director*

EDUCATION UNIT**RAND GRADUATE SCHOOL**

Robert Klitgaard, *Dean*

Board of Trustees

- Ronald L. Olson (Chairman), *Partner, Munger, Tolles & Olson*
- Ann McLaughlin Korologos (Vice Chairman), *Chairman Emeritus, The Aspen Institute; former Secretary of Labor*
- Carl Bildt, *Former Prime Minister of Sweden*
- Peter S. Bing, *Private Investor*
- Harold Brown, *Counselor, Center for Strategic and International Studies*
- Frank C. Carlucci, *Chairman, The Carlyle Group*
- Lovida H. Coleman, Jr., *Partner, Sutherland, Asbill & Brennan LLP*
- Robert Curvin, *President, Greentree Foundation*
- Pedro Jose Greer, Jr., M.D., *Assistant Dean, University of Miami School of Medicine*
- Rita E. Hauser, *President, The Hauser Foundation, Inc.*
- Karen Elliott House, *President, International Group, Dow Jones & Company, Inc.*
- Jen-Hsun Huang, *President and Chief Executive Officer, NVIDIA Corporation*
- Paul G. Kaminski, *Chairman and Chief Executive Officer, Technovation, Inc.*
- Bruce Karatz, *Chairman and Chief Executive Officer, KB Home*
- Philip Lader, *Chairman, The WPP Group*
- Arthur Levitt, *Senior Advisor, The Carlyle Group*
- Lloyd N. Morrisett, *Retired President, The Markle Foundation*
- Amy B. Pascal, *Chairman, Columbia Pictures*
- Patricia Salas Pineda, *Vice President, Legal, Human Resources, Environmental & Government Affairs and Corporate Secretary, New United Motor Manufacturing, Inc.*
- John Edward Porter, *Partner, Hogan & Hartson*

John S. Reed, *Retired Chairman, Citigroup*

Donald B. Rice, *President and Chief Executive Officer, Agensys, Inc.*

Kenneth I. Shine, M.D., *President, Institute of Medicine,
National Academy of Sciences*

Jerry I. Speyer, *President, Tishman Speyer Properties, Inc.*

James A. Thomson, *President and Chief Executive Officer, RAND*

James Q. Wilson, *James A. Collins Professor Emeritus of Management,
The John E. Anderson Graduate School of Management,
University of California, Los Angeles*

February 2002

