Annual Report 2010

RAND PROJECT AIR FORCE

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About RAND Project AIR FORCE

The mission of RAND Project AIR FORCE (PAF), a division of the RAND Corporation and the Air Force's federally funded research and development center for studies and analyses, is to undertake 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 workforce? How can that workforce be most effectively recruited, trained, and retained? How should sustainment, acquisition, and infrastructure be streamlined to control costs? PAF carries out its research agenda 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.

Force Modernization and Employment 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, develop, 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 the areas of 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 research on topics that cut across all four programs, and its research staff regularly responds to Air Force requests for help on time-urgent problems.

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Message from the Director

Andrew R. Hoehn

As I enter my fifth year as director of Project AIR FORCE (PAF), I find myself reflecting on the impressions that developed during my first few months in the role. Most striking at the time were my perceptions of my PAF colleagues—their diversity, expertise, and dedication to task. Now, after having had the opportunity to interact extensively with individuals and research teams and to develop a detailed knowledge of the work they do, I see something that was not quite so clear in those early days. The people who work in PAF also have a passion for the Air Force itself.

Why is this? Where does the passion come from? I believe there are three main reasons for it. The first is the nature of the Air Force mission, both in supporting today's wars and in preparing to meet future threats. Accomplishing that mission requires consistently superior performance on the human level and a range of technological capabilities that, arguably, are unmatched anywhere else in the world. The Air Force can be a game changer, and PAF researchers are seized with the idea of helping create game-changing alternatives. Moreover, warfighting is only one of the dimensions in which the Air Force excels. The nation depends on the Air Force to deter threats and play widely recognized roles in antiterrorism, humanitarian relief, and nation-building. All these things combine to create an aura of excellence that inspires both enthusiasm and commitment.

PAF researchers know that they best serve the Air Force through the objectivity and quality of their research. But their level of effort and their dedication could not be sustained without passion for the work and for the service that makes it all possible.

The second reason is that PAF's 64-year partnership with the Air Force allows us to work on issues that are among the core concerns of the Air Force leadership—not just those at the margins, where the problems may be intellectually engaging but where the solutions ultimately do little to enhance the Air Force's ability to reach its goals. More than that, our Air Force audiences listen to what we say. They may not always agree, but they are willing to consider alternative views and approaches, and they base their decisions on empirical evidence. This means our work is taken seriously, and what we do makes a difference. I believe that, in a poll of PAF researchers to find out what they value most about their jobs, "making a difference" would be by far the most popular answer.

The third reason behind this passion for the Air Force can be found in the types of people who are attracted to PAF. Some of them have been fascinated by the mechanics of flight from a very early age. They grew up attending air shows and technical expos, reading aviation-related publications, and talking about aerodynamics and aircraft engineering around the kitchen table. Others came to PAF seeking an opportunity to apply their subject-matter expertise, only to discover that, in doing so, they had become absorbed in larger Air Force issues. Finally, there are staff members with previous Air Force careers—pilots who have flown hundreds of missions, as well as officers, enlisted personnel, and civilians responsible for strategic analyses, technology development, logistical and manpower support, training, and other functions. Their "insider" perspective is invaluable in keeping our work focused on the Air Force's highest priorities and in maintaining ongoing relationships with its personnel at bases and commands throughout the world.

When the individuals whose research is highlighted in this edition of the annual report were being interviewed for their personal profiles (which are included in the text), two of them described

working for PAF as a "dream job"—often demanding but always satisfying. And that is exactly what it is: a dream job for the inquisitive and analytical, offering one interesting challenge after another. Every day, PAF researchers devote themselves to helping the Air Force solve its toughest problems. They provide decisionmakers with the information and options they need to maintain superior performance, effectiveness, and efficiency. They know that they best serve the Air Force through the objectivity and quality of their research. But their level of effort and their dedication could not be sustained without passion for the work and for the service that makes it all possible.

Andrew R. Hoehn
Vice President, RAND Corporation
Director, Project AIR FORCE

Next-Generation Long-Range Strike Capability

Getting Back to Basics to Analyze Cost-Effective Options

A B-1B Lancer flies a combat patrol over Afghanistan during Operation Enduring Freedom. (Inset: a B-52 from the 1950s.) RAND has been helping the Air Force and DoD develop an effective and efficient LRS capability since the 1950s.

In 1954, the RAND Corporation prepared a report for the U.S. Air Force that called for U.S. basing of bombers to ensure that the United States had the ability to strike back in the event of a Soviet nuclear attack. That study led to a major change in the strategic use of bombers, which until then had been based forward but were open to surprise attack. The new posture also established a stronger deterrence to nuclear war that has lasted to this day.

Today, RAND is still helping the Air Force and the Department of Defense (DoD) think about the best ways to employ long-range strike (LRS)—including its use in conventional conflicts. "Bombers continue to play an important role in conventional operations," says James Chow, a senior engineer at RAND who has led a series of studies on LRS over the past several years. "Some of the same B-52s that flew nuclear deterrence missions during the Cold War have been used to fight the Taliban in Afghanistan. These aircraft can drop a large number of precision bombs yet can operate from bases too distant for shorter-range fighters. They provide commanders the flexibility to operate in regions where access to basing may be limited. In the case of Afghanistan, it allowed us to successfully conduct ground operations with a smaller number of troops."

Despite the contributions that bombers are making to today's counterinsurgency operations, military planners are concerned about the tougher jobs that could lie ahead against adversaries with antiaccess and area-denial capabilities. "A near-peer adversary with integrated air defenses and the ability to push U.S. forces away from the fight would present a bigger challenge than we face today."

Clarifying Options for Future Long-Range Strike Capabilities

In response to these concerns, the Office of the Secretary of Defense (OSD) is sponsoring a study of cost-effective options for providing an LRS capability over the next thirty years. Jim and a team of RAND researchers are conducting the study in coordination with a working group comprising representatives from OSD, the military services, and the combatant commands. "We are taking a completely fresh look at the problem to see how different types of systems could contribute. We need to think about a family of systems that could provide LRS capabilities against a range of threats. This might include bombers, standoff aircraft, cruise missiles, conventional ballistic missiles, and supporting such capabilities as intelligence, surveillance, and reconnaissance and airborne electronic attack."

Although the current study has a joint focus, the methodology draws from several years' worth of research that Jim and his colleagues have conducted for the Air Force. "In 2007, we were already thinking about the need to look at LRS as a package of capabilities that included penetrating intelligence, surveillance, and reconnaissance. In 2009, we started working on a methodology that would help the Air Force assess

the cost-effectiveness of different LRS assets under a variety of operational conditions. That work led directly to what we are doing now for OSD. The Air Force knows the importance of getting LRS right, and it is willing to invest in this analysis."

The purpose of this study is not to predict future conflicts but to present decisionmakers with a range of options that would be cost-effective under different operational conditions.

Preliminary insights from the study suggest that the appropriate mix of LRS systems will depend on the type and intensity of conflicts that the United States is likely to be involved in over the next thirty years. "If policymakers expect a period of relative peace, it doesn't make sense to invest in a new bomber. But if they want to hedge against the possibility of the United States being involved in a major conflict, or a series of smaller conflicts, it appears that having a reusable LRS capability would be important." Jim emphasizes that the purpose of this study is not to predict future conflicts but to present decisionmakers with a range of options that would be cost-effective under different operational conditions. "The investment decisions DoD makes today will persist for decades. We want to help clarify which options make the most sense, both for the U.S. budget and for the nation's security."

Breaking Problems Down to Fundamentals

Throughout his career at RAND, Jim has studied large policy problems involving force mix, force employment, aircraft survivability, and other issues—but he sees them through an engineer's eyes. "Engineers are practical. We break problems down into component parts to understand the fundamental forces at work. In aerospace engineering, that kind of approach helps you overcome technical hurdles and design better aircraft. In defense policy analysis, it helps you see what's really driving the problem and identify options for fixing it."

Jim's lifelong fascination with aircraft led him to study aerospace and aeronautical engineering, ultimately leading to a doctorate in the subject at Stanford. "My original idea was to work for an aerospace company. These companies work on diverse projects, but the offers I had at the time

A B-2 Spirit flies over Afghanistan in Operation Enduring Freedom. Policymakers are considering which family of LRS systems will best prepare the Air Force for future conflicts.

were for positions that would force me to narrow my focus. I was less interested in building the perfect landing gear and more interested in how technology drives the way aircraft are used in a military setting."

At RAND, Jim found a place to apply his technical knowledge to the kinds of high-level policy questions he had begun following with curiosity in high school. Since joining RAND in 1997, he has worked on projects that examined aircraft survivability, threats to commercial aviation from shoulder-fired missiles, and future roles for remotely piloted aircraft, to name only a few. He has also served in management positions as head of the Technology and Applied Sciences group and as associate director of RAND Project AIR FORCE's (PAF's) Force Modernization and Employment program. All his work is marked by an interest in how aircraft engineering bears on complex military policy decisions.

James Chow

Taking an engineer's approach to policy questions has allowed Jim to expand his interests beyond aircraft and to examine the family of systems that contribute to a robust LRS capability. "Weapon systems, delivery and launch platforms, and supporting systems that provide intelligence and protection—these are the building blocks of a capability that may have to stand up to many different kinds of stress and do so in a cost-effective way. In that sense, designing the right force mix is not much different from designing the right airframe. You want to build the most flexible and resilient capability you can with the resources you have."

Cyberwar and Cyberdeterrence

How Worried Should We Be?

Col Rob Kyrouac (center) leads the crew of the Korean Air Operations Center during Exercise Key Resolve. This joint U.S.–Republic of Korea training exercise is held annually to ensure combat readiness of air, space, and cyberspace operations in the Korean theater of operations.

For centuries, wars took place only on land and at sea. At the beginning of the 20th century, warriors took to the air and then, as the century waned, began to take advantage of the high ground of space. The recent establishment of the 24th Air Force and U.S. Cyber Command is a response to a potential fifth domain of warfare: cyberspace. Many believe that the historical constructs of war—force, offense, defense, and deterrence—will apply equally well to cyberspace, with little or no modification. But this is not so; cyberspace is its own medium with its own rules.

The very definition of cyberspace is plastic and contentious. However, for this discussion, *cyberspace* can usefully, if narrowly, be described as analogous to the Internet and similar networks: a collection of individual computing devices networked both to one another—for example, an office local-area network or a corporate wide-area network—and to the outside world.

A *cyberattack* is a state's deliberate disruption or corruption of a system of interest to another state. Cyberattacks can be launched from outside the network, using hackers, or from inside the network, using agents and rogue elements. Cyberattacks are not about physical force but exploitation of enemy vulnerabilities. *Cyberdeterrence* refers to capabilities that would allow the United States to do the same, the chief purpose being to create disincentives for starting or escalating hostile actions.

To help the Air Force understand the key characteristics of cyberwar and respond with appropriate and effective policy decisions, PAF undertook a research effort that focused on what cyberwar means, what it entails, and whether it is possible to deter others from resorting to it. The main findings of that study are highlighted below.

Cyberattacks Are Possible Only Because of System Flaws

As long as nations rely on computer networks as a foundation of military and economic power and as long as the networks are accessible from the outside, they are at risk. Hackers can steal information, issue phony commands to information systems to cause them to malfunction, and inject phony information to lead humans and machines to reach false conclusions and make bad (or no) decisions. System vulnerabilities do not, however, stem from immutable physical laws but from inevitable gaps in design between theory and practice. In theory, a system should do only what its designers and operators want it to. In practice, it does exactly what its code and settings tell it to. The difference exists because systems are complex and growing more so.

But therein lies a saving grace. Errors can be corrected, and the degree of accessibility from the outside can be specified. In the end, there is no forced entry in cyberspace. Mischief-makers get in because someone left a door unlocked. It is only a modest exaggeration to say that systems are vulnerable to cyberattack only to the extent their makers want them to be. In no other domain of warfare can such a statement be made.

Operational Cyberwar Can Play Only a Niche Role

For operational cyberwar—acting against military targets during a war—to work, targets must be accessible and vulnerable. Moreover, these vulnerabilities have to be exploited in ways useful to the attacker. One difficulty is that it is hard to predict the *effects* of a cyberattack. To do so, the attacker needs to know how the system and its operators will respond to signs of dysfunction and how the processes and systems associated with the system will behave. Even then, cyberwar operations neither directly harm individuals nor destroy equipment (with some exceptions).

The transient effects of cyberattacks suggest that they are better suited to one-shot strikes—e.g., to silence a surface-to-air missile system—than to long campaigns—e.g., exerting constant pressure on a nation's capital. Attempting a cyberattack in the hopes that success will facilitate a combat operation may be prudent; betting the operation's success on a particular set of results may not be.

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Strategic Cyberwar Is Unlikely to Be Decisive

No one knows how destructive any one strategic cyberwar attack would be. Dollar estimates of damage vary wildly, but the higher numbers suggest that cyberattacks on enemy civilian infrastructures—strategic cyberwar—may be rationalized as a way to help military efforts or as a way to coerce the other side to yield to prevent further suffering. But cyberattacks are not like strategic bombing, which, when it works, does so when populations conclude that things can only get worse. The opposite occurs with cyberattacks. As attacks continue and vulnerabilities emerge, system operators fix them, work around them, or reduce outsiders' access to them. And there is the possibility of escalation, perhaps into one of the traditional domains.

Cyberdeterrence Is Not the Same as Nuclear Deterrence and May Not Work as Well

Cyberdeterrence is fraught with ambiguities. Cold War nuclear deterrence was not. Attribution of attack was not a problem; the prospect of battle damage was clear; the 1,000th bomb could be as powerful as the first; counterforce was possible; there were no third parties to worry about; private firms were not expected to defend themselves; any hostile nuclear use crossed an acknowledged threshold; no higher levels of war existed; and both sides always had a lot to lose.

What is there about cyberspace that would prevent a similar posture from working similarly well? Plenty, as it turns out. Issues that simply do not crop up with nuclear or even conventional deterrence turn out to matter in cyberspace whenever the victim of an attack contemplates retaliation. The following questions underscore the difference:

- Will we know who did it?
- Can retaliators hold assets at risk?
- Can they do so repeatedly?
- Can cyberattacks disarm cyberattackers?
- Will third parties stay out of the way?
- Will retaliation send the right message?

- Can states set thresholds for response?
- Can escalation (possibly into other domains) be avoided?

Unless these questions can be answered positively with relatively high confidence, achieving an effective deterrent effect is, at best, problematic and, at worst, counterproductive.

The difficulties can be illustrated by considering just the first question. Retaliation requires knowing who launched the attack. In nuclear deterrence, only a handful of adversaries *could* mount an attack, and we were always watching them. But anyone can launch a cyberattack and do it from anywhere: cyber cafés, open Wi-Fi nodes, and co-opted third-party computers. Cyberattacks do not require expensive or rare machinery. They leave next to no unique physical trace. Thus, attribution is often guesswork.

True, ironclad attribution is not required for deterrence. An attacker must simply believe he might be hit back. But some reasonable level of proof may be necessary, given that (1) the attacker may believe it can shake the retaliator's belief that it got attribution right by doing nothing different ("who, me?") in response to retaliation; (2) mistaken attribution makes new enemies; and (3) neutral observers may need to be convinced that retaliation is not aggression.

Responses to Cyberattack Must Weigh Many Factors

Ambiguity is, perhaps, the most notable characteristic of cyberwar. For example, it may be difficult to determine what the attacker was trying to do. Because cyberwar can rarely break things, much less take things, the more obvious motives of war do not apply. If the attacker meant to coerce but kept his identity secret, will the goal of the coercion be clear? What should the victim reveal about the attacker? Effects might not be obvious, but revealing identity might be necessary to justify retaliation to the public. Decisions about whether and when to name the attacker also deserve thought. Speaking too soon may be embarrassing; waiting too long erodes the credibility of

The reflection of senior forensic technician Scott Lalliss appears on the highly reflective disk of a hard drive undergoing sonic cleaning at the Defense Computer Forensic Laboratory in Linthicum, Maryland. Here, a 91-percent alcohol, 9-percent water solution produces bubbles that gently move dirt and other organic matter away from the disk. The surface requires careful handling to prevent damage and thus preserve data that may be valuable evidence for an investigation.

Martin Libicki

Martin Libicki has spent nearly two decades mulling over a concept that started in the world of fiction and is only now working its way into reality: cyberspace. In fact, he is currently teaching a course on cyberwar at Georgetown University, where one of his goals is to help his students "become more intelligent participants in discussions on the topic." Cyberwar is engendering an increasingly raucous debate. Pointing to modern-day reliance on computers and the Internet—communications, financial networks, power grids, air traffic control, industrial processes, and, not least, defense systems—many people believe that a cyber assault could bring society instantly to its knees. At the other end of the spectrum are those who say the threat is entirely manufactured by those eager to expand their empires and pocketbooks.

Martin takes a moderate position: "We should be serious but not desperate." These days, such a perspective makes him a skeptic among his peers. Cyberwar is so often used for sensationalism: think about blockbuster movies like *Independence Day* and *Live Free or Die Hard*, for example, whose plots revolved around the ability of supersmart folks to hack into every system imaginable (even those designed by aliens). "But we should always be suspicious when we get our military cues from Hollywood." Instead, he advises the Air Force to understand what it needs from cyberspace, take a gimlet-eyed view of the possible, and then develop military strategies and policies accordingly.

I have thought a great deal about how to walk the gap between technology and strategy. And in my current research, I have been trying to help the Air Force think about ways to use cyber concepts both defensively and offensively.

In his 12 years as a senior management scientist at RAND, Martin has focused on the broad relationship of information technology to both domestic and national security. In other studies, he has addressed such topics as information technology standards, counterinsurgency, terrorism, demographics, surveillance against privacy, and information system acquisition. "I'm not a hard-core techie—I call on my daughters to set the DVD correctly—but I have thought a great deal about how to walk the gap between technology and strategy. And in my current research, I have been trying to help the Air Force think about ways to use cyber concepts both defensively and offensively."

Before he came to RAND, Martin spent more than a decade as a senior fellow at the National Defense University, where he worked on cyberwar and military transformation. He is more than willing to explain how his current interests have evolved in an inevitable progression from his background in industrial economics, acquired while earning a master's degree and doctorate in city and regional planning at U.C. Berkeley.

Over the years, Martin has been as busy personally as he has professionally. He and his wife are the parents of three daughters, ages 16, 18, and 19. Indeed, he believes that those who have raised children have a special understanding of such concepts as deterrence, escalation dominance, crisis management, strategic deception, border adjudication, conflict resolution, and negotiation under stress.

SrA Sean Reuter, a network systems technician at an air base in Southwest Asia, taps into the Global Broadcast System, a worldwide high-capacity transmission vehicle for a variety of data, imagery, and other information required to support joint forces.

the response. How should states respond to freelance attacks? Did the host state know at all? Did it simply turn a blind eye? Or did it just not pursue the attackers with enough vigor? These questions and many others require responses that are not necessary in other domains of war.

Implications for the Air Force

The United States and, by extension, the U.S. Air Force should be cautious about making strategic cyberwar a priority investment area. Strategic cyberwar, by itself, would annoy but not disarm an adversary. Any adversary that merits a strategic cyberwar campaign to be subdued also likely possesses the capability to strike back in ways that may be more than annoying.

Similar caution is necessary when contemplating cyberdeterrence. Attribution, predictable response, the ability to continue an attack, and the lack of a counterforce option are all significant barriers. The United States may want to exhaust other approaches—diplomatic, economic, and prosecutorial—first.

Operational cyberwar has the potential to contribute to warfare, but much is unknown and, to a large extent, unknowable. Because a devastating cyberattack may facilitate or amplify physical operations and because an operational cyberwar capability is relatively inexpensive, such a capability is worth developing. That noted, success at cyberwar is not only a matter of technique but also one of understanding the adversary's networks in the technical sense and, even more, in the operational sense (how potential adversaries use information to wage war). The best cyberattacks have a limited shelf life and should be used sparingly.

Throughout all this, cyberdefense remains the Air Force's most important activity within cyberspace. Although most of what it takes to defend a military network can be learned from what it takes to defend a civilian network, the two differ in important ways. Thus, the Air Force must think hard as it crafts its cyberdefense goals, architectures, policies, strategies, and operations.

FOR MORE INFORMATION, SEE

Cyberdeterrence and Cyberwar, by Martin C. Libicki, MG-877-AF
http://www.rand.org/pubs/monographs/MG877/

Eyes on the Prize

Behind the Scenes in PAF's Resource Management Program

Laura Baldwin

When Laura Baldwin came to RAND in 1994, fresh from earning her doctorate in economics from Duke University, little did she imagine that in five short years she would be the associate director of PAF's Resource Management program (RMP) and then, by 2007, its director.

RMP's overarching goal is to help the Air Force maximize its operational effectiveness in a resource-constrained environment. The program works with a wide range of Air Force organizations and has a long history of research for the Air Force's acquisition and combat support communities. In her own research for the Air Force, Laura has addressed such diverse topics as applying best commercial practices for purchasing and supply management, managing aging aircraft weapon systems, and examining how acquisition reform affects the acquisition workforce.

While she has no favorites among her many projects, two relatively recent ones stand out, mainly because of their potential for surprises. From 2004 through 2006, the Air Force asked PAF to help improve its contracting support of contingency operations during Operation Iraqi Freedom. The research team worked with U.S. Air Forces Central to develop a database for all the day-to-day things that were being purchased in theater. "They gave us spreadsheet after spreadsheet of data that deployed contracting officers had entered by hand. We got to see everything they were buying in the deployed environment to support the bases and the people living on them—for example, all the construction supplies to build runways and put together rooms on a bare base, equipment for gyms, food-service supplies, computers for the offices, and even goggles (called *doggles*) to protect the eyes of the bomb-sniffing dogs from sand and debris. It took a long time to wade through all that material, but it was fascinating." The interactions between the PAF researchers and U.S. Air Forces Central contracting personnel helped the Air Force develop a new approach for tracking purchases in theater that would facilitate more-informed buying.

Laura's second example comes from the congressionally mandated analysis of alternatives for KC-135 recapitalization that RAND completed in 2005. "The project leader asked a colleague and me to look at options for commercial sourcing of tanking services and see whether they might make economic sense. One might question such a study because there is no obvious commercial equivalent for this kind of capability. However, at the time of the study, there were two military examples: The U.S. Navy was sourcing one tanker from a commercial provider and was considering a second. The United Kingdom was also establishing a business relationship with a commercial provider so that aircraft would be properly configured for military tanking when needed and could be used for commercial cargo-hauling and other activities the rest of the time. Of course, the scale was very small compared to what the Air Force does, but we learned about structuring arrangements that

The scale of the other tanker programs was very small compared to what the Air Force does, but we learned about structuring arrangements that I hadn't even known existed. And the real challenge was to think about whether they might work for the Air Force.

I hadn't even known existed. And the real challenge was to think about whether they might work for the Air Force."

Laura's years of experience as a researcher have taught her what it takes to be successful. Now, as a program director, she applies this knowledge broadly to help recruit and mentor new staff and to work with project leaders throughout the planning and conduct of RMP's research agenda.

Investing in people provides big payoffs to both PAF and the Air Force. We create individual plans to develop staff as quickly as we can.

The Project Leader Makes Things Happen

PAF places a high premium on hiring the best people available, then providing them opportunities that will expand their knowledge and skills and enable them to assume leadership roles. Laura points out that, "Investing in people provides big payoffs to both PAF and the Air Force. We create individual plans to develop staff as quickly as we can." Such plans generally address a basic set of questions:

- Are we giving new staff the right kinds of research experiences?
- How do we intend to get them out to see the Air Force, attend meetings with Air Force personnel, etc.?
- How will we prepare them for the next level—task leadership, co–project leadership?
- Are they being given the proper guidance and feedback on their research, briefings, and publications?

"The trick is figuring out how to move people along fast enough that they don't get bored and go do other things but not so fast that they get in over their heads."

RMP's project leaders interact frequently with the Air Force at all the levels necessary to get the work done. This generally begins in discussions with sponsors to identify the problem they need help with and to shape the research methodology so that the end result is a useful product with actionable recommendations. Success here includes knowing the Air Force's internal schedules so that research results are available early enough to affect or inform key decisions.

Once the groundwork has been laid, the project leader and team spend time with a variety of working-level personnel to gather data relevant to the study, for example, getting to understand related initiatives, organizational structures, maintenance processes, acquisition processes—whatever is necessary to get the job done the right way at the right time. "Being a project leader is what it's all about," says Laura. "In PAF, those are the people who really make a difference."

The Program Director's Job Is to Keep Things on Target

Laura views her job as different from, but closely related to, the one that project leaders do. "Most of the time, I'm interacting with the sponsor community, trying to shape products and put together an RMP research agenda that meets their needs. As each fiscal year kicks off, I try to attend as many meetings as I can between the sponsors and project leaders so that I have a clear understanding of the sponsors' expectations and so

SSgt Philip Mendoza pets his military working dog, Rico, who is wearing "doggles" while training aboard a helicopter at Joint Base Balad, Iraq. The training teaches dog and handler how to safely and properly enter and exit aircraft and prepares the team for future air-assault missions. Doggles are among the thousands of items that deployed contracting officers purchased to support contingency operations during Operation Iraqi Freedom.

that I can keep working with the project leaders to make sure we meet those expectations."

Laura's primary role, as she sees it, is to keep things on target. "Research is not a linear process. There are lots of reasons to poke in different directions. But we have to measure everything we do by one yardstick: Will it help us with the big question that is important to the sponsor?" She is very clear about her top priority, which is to ensure that RMP is doing the best possible work for the Air Force. That means enabling the project leaders and their teams to do what they do best, helping them when they need it, getting out of the way when they don't, and encouraging them along their career paths.

RMP's Research Affects Air Force Decisionmaking

One way Laura measures the success of RMP's work is through the quality of the research and the degree of its influence within the Air Force. Asked to cite a few examples, she mentions the following:

- **Agile Combat Support (ACS) Planning, Execution, and Control.** The Air Force has asked for help determining better ways to use its limited ACS resources to support operational requirements and warfighter priorities. RMP and Air Force ACS personnel are working together to improve the integration of the ACS community into Air Force command and control processes to find the most effective ways to allocate resources among competing priorities. An important goal of this work is to give commanders the means of evaluating options and risks during execution.
- **Managing the F-22A Raptor.** In recent years, PAF has conducted a series of studies centering on this advanced tactical fighter. The findings of RMP's acquisition policy and cost-analysis group allowed the Air Force to award a multiyear procurement contract for 60 Raptors at an estimated savings of over $400 million. When the question arose about whether a key sustainment management function for the

F-22A should be outsourced to a private contractor, RMP research findings convinced the F-22 program office to conduct a detailed business case analysis much earlier than it had planned. When the time came to plan for shutting down F-22A production, RMP assessed the value of retaining certain specialized production tooling. The analysis demonstrated that retaining and storing the tooling in question would be a cost-effective way to reduce program risks, given the possibility that the tooling or costly replacements might become necessary to repair battle-damaged aircraft or conduct a major service-life-extension program. As a result, the Air Force decided to retain this tooling.

- **Consolidating Aircraft Maintenance.** RMP examined the prospect of centralizing unit-level maintenance activities not required for sortie generation to reduce costs through economies of scale and to get high-demand aircraft back in service more quickly. Researchers analyzed global repair network options to support the C-130, KC-135, and F-16 fleets and found that consolidating certain maintenance tasks at centralized facilities would help the Air Force achieve these goals. The potential savings would be $300 million annually for these three fleets, and additional aircraft would indeed become available. Furthermore, the Air Force has options for the number and locations of the facilities that do not sacrifice either financial or operational benefits. The Air Force's Repair Network Integration effort is undertaking a phased approach to implementing these concepts.

Laura sums up by saying, "Our job is to provide objective, analytically solid information to help the Air Force's senior leaders make the hard decisions, not to advocate for a particular path. We want to illuminate alternatives as effectively as we can and show how various options can be evaluated. We will never understand all the things that the Air Force leaders have to take into account. The best we can do is provide them with research results they can use to make and defend the decisions they believe are right."

Our job is to provide objective, analytically solid information to help the Air Force's senior leaders make the hard decisions, not to advocate for a particular path.

A1C Jessica Guinn, an aerospace propulsion apprentice, tightens clamps around an actuator on an F-16 Fighting Falcon during some late-night maintenance. PAF researchers found that consolidating certain maintenance and repair tasks at centralized facilities could save the Air Force as much as $300 million annually.

Striking a Work-Life Balance Is Important

In this discussion, the emphasis so far has been on research and the people who are responsible for getting it done. But there is another side to the story that involves striking the right balance between one's career and personal life, so that both are more fulfilling. These days, it would be hard to find anyone who disagrees with the concept, but relatively few seem able to make it a reality. Laura is one of the lucky ones. She says that the credit belongs entirely to her husband, Glenn, a stay-at-home dad, who keeps everything running smoothly and supervises their two "nearly perfect" children, Sarah, age 10, and Lincoln, age 4.

That peace of mind has no doubt helped Laura earn a reputation for being calm, unflappable, and highly competent. However, her colleagues do accuse her of one obsession: Disneymania. She doesn't deny it. "I travel so much that we make it a point to take as many family vacations as we can squeeze in." The big ones are the annual excursions to Disney World in Orlando, Florida. "We love going on the rides and seeing the characters. Besides finding the trips fun and relaxing, I am fascinated by the logistics that keep such a large, complex organization running so well." Overall, she says, her personal life keeps her sane. "It's the reason I can come to work and be productive, travel, and do all the other things I have to do."

FOR MORE INFORMATION, SEE

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Strategic Awakening

The Air Force and the Emerging U.S. Strategy Toward Africa

As part of a search-and-rescue exercise conducted at Camp Lemonier in Djibouti, Africa, Air Force pararescuemen secure "injured" patients on stretchers before transporting them on a Marine CH-53 Super Stallion helicopter.

Africa has traditionally been a backwater of American foreign policy. Recently, however, the continent's strategic dynamics have shifted in ways that present important new challenges for the United States, particularly with respect to the rise of potent transnational terrorism and growing prospects for rivalry among the great powers. U.S. strategy in Africa is evolving in response to these challenges, and the ends, ways, and means of American involvement in the region are in flux.

In 2007, PAF began a series of studies of emerging U.S. interests in the region, long-term dynamics that could threaten those interests, and the potential role of the U.S. military—especially the Air Force—on the African continent. PAF's multiyear effort was conducted by an interdisciplinary team composed of more than a dozen RAND analysts, including specialists in African political and security affairs, insurgency and terrorism, and security force assistance specialists, as well as development and energy economists, aerospace engineers, and air mobility analysts.

The team concluded that external actors, such as the United States, cannot ultimately resolve the fundamental sources of Africa's strategic challenges. Therefore, U.S. strategy should instead stress "limited objectives, limited liability," in which the U.S. armed forces play a secondary, though important, role. When American military power is employed, it should be indirectly, through security cooperation and training, advising, and assisting African partners. Within this construct, however, Air Force participation will be vital because of the size of the African landmass, its challenging topography, and its severely underdeveloped surface-transportation infrastructure.

U.S. Interests in Africa

Ensuring the Security of the American Homeland. Where Africa is concerned, the primary U.S. goal is preventing al-Qaeda and affiliated movements from establishing African sanctuaries from which they can conduct regional or global operations. Al-Qaeda and its affiliates are already active in several parts of the continent. In East Africa, the al Shabaab militia has established a sanctuary in Somalia from which it is attacking neighboring states and threatening the Arabian peninsula. In West Africa, al-Qaeda in the Islamic Maghreb is becoming increasingly powerful, but a delicate political balance still holds between radicals and more-moderate elements. In South Africa, a radical fringe has the potential to exploit that country's excellent communications, banking, and transport infrastructure for an operational base for sophisticated attacks. A U.S. response to these challenges must be equally diverse and carefully modulated to avoid making the problem worse over the long run.

Protecting Africa's Energy Exports. America also has interests in Africa that are important, if not strictly vital, such as the security of West African energy exports. West Africa's role as a global energy supplier has expanded in recent years. The high quality of the region's crude oil, which is low in sulfur and other contaminants, makes it suitable for

The principal characteristics of the African security environment are weak states, chronic poverty, and endemic conflict.

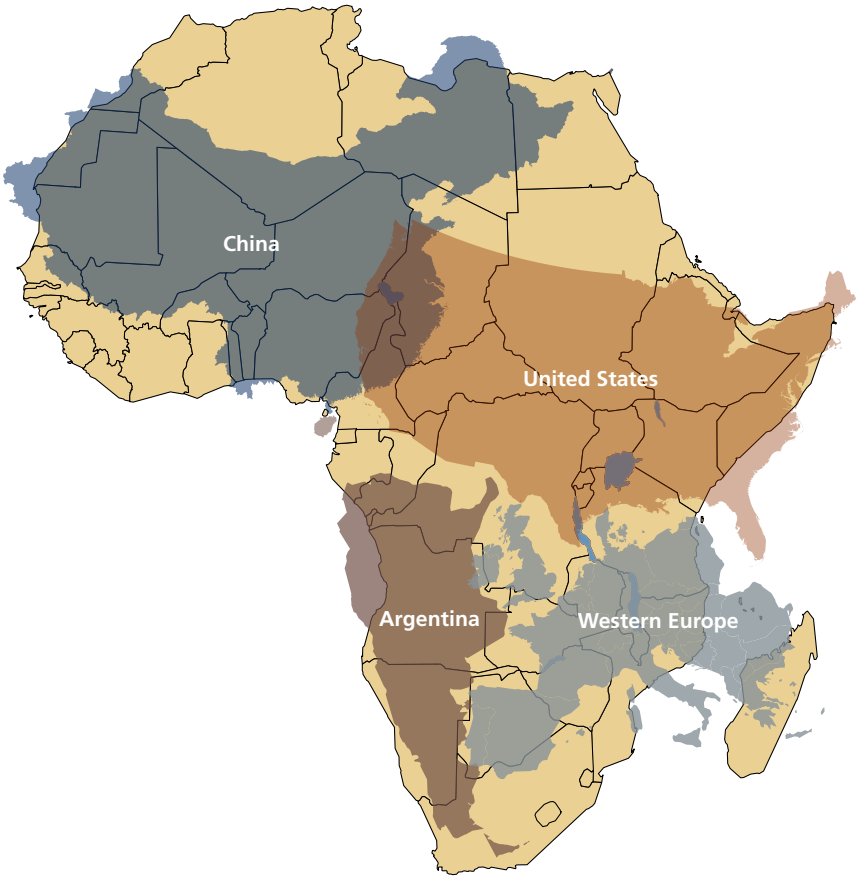
refining in many countries. In case of supply disruptions, traders can "swing" West African crude to countries whose refineries cannot handle heavier crude from, for example, the Persian Gulf. However, the region is unstable, with insurgents, militias, and criminals routinely interrupting exports and sabotaging oil pipelines. While a major disruption of the West African supply would not be on the same scale as such an event would be in, say, the Arabian Gulf, it would still have a significant effect on the U.S. economy. It is therefore reasonable for the United States to invest modestly in the security of West African oil suppliers.

The growing importance of African raw materials to the smooth functioning of the Chinese and Indian economies will lead both powers to become more involved in Africa. At the same time, European economies will become less dependent on these materials and markets. This makes it likely that individual European governments will become less involved in the area and that the roles of the European Union, China, and India will rise correspondingly. China and the United States may find that their common interest in the region (i.e., a more prosperous Africa that will trade more with the rest of the world and be better equipped to solve its own security problems) outweighs their conflicting interests. At times, however, the near-term interests of the major external powers will come into conflict. A key U.S. objective will be to prevent these situations from spiraling into competitions that disproportionately damage other relationships and interests around the globe.

The African Security Environment

The principal characteristics of the African security environment are weak states, chronic poverty, and endemic conflict. The study's results indicate that these conditions are deeply rooted in geographic, demographic, economic, and political realities that are essentially beyond the ability of the United States to remedy decisively.

TSgt Phillip Derenski talks with Rwandan Lt. Kadhafi Ntayomba on a C-17 Globemaster from McGuire Air Force Base, New Jersey. The United States transported 1,200 Rwandan forces to Sudan as part of a NATO effort to support the African Union's expanded peacekeeping mission in Darfur.



Just How Big Is Africa?

Effects of Geography on the African Economy. Africa is an enormous continent of approximately 11.7 million square miles. Representing about 20 percent of the earth's land surface, it is larger than the United States, China, and Western Europe combined (see map).

Overall, the continent is arid and becoming more so in response to climate changes. Coupled with low soil fertility and comparatively high rates of tropical diseases, these conditions have long suppressed population density across much of the African interior. Consequently, social and political structures in much of Africa center on small, diffuse units (family, village, clan) rather than nation-states of the sort that have developed in more densely populated regions of the world.

Africa Is Poor and Getting Poorer. About 75 percent of Africans are estimated to live on less than two dollars a day. Even in Botswana, one of Africa's wealthiest states, a quarter of the population lives in poverty.[1] Economic growth over the past thirty years has been essentially stagnant (at 0 percent). This is partly because Africa's role in the global economy is shrinking. During the first wave of independence in the early 1960s, African imports and exports made up approximately 4.5 percent of global trade; that number has dwindled to 1.5 percent. In addition to geographic and demographic conditions, corruption and ineffective economic policies handicap African economies. According to the World Bank Institute, only the countries of the former Soviet Union are more corrupt than those of Africa.[2]

Many African central governments can no longer be exclusively or even largely responsible for national security.

Study findings indicate that, on balance, Africa's long-term economic prognosis is mixed to poor. Desertification related to climate change is likely to hit many interior states that rely heavily on agriculture hard. Political instability will also take a severe toll on many economies. The continent's more-diversified economies will fare better, particularly if global trade continues to expand over the long run. So far, however, there is no evidence of an impending transformation across the continent that would address its issues as a whole. Therefore, the aggregate African regional economy is unlikely to fundamentally alter its historical trajectory. The PAF research team concluded that it would be imprudent for DoD to base its strategy on the expectation of such transformation in the next twenty years.

Weakness of the African State System. The principal characteristic of the African political context is a lack of state capacity. While truly failed states are relatively rare (Somalia and Democratic Republic of Congo are the only two large countries that can truly be said to have collapsed), "failing" states are abundant. By most measures, African states are weaker today than they were during the independence era of the 1960s. According to the PAF analysis, several factors appear to be contributing to this trend, including the prevalence of personalistic leadership (the "big man"—in practice, a ruler who controls patronage networks and prevents development of enduring state institutions[3]); the crippling of state institutions to thwart rivals; and globalization, which has diminished state sovereignty.

The weakness of the African state system sets the stage for widespread endemic conflict. These conflicts occur within and beyond state borders. Many key players are nonstate actors—insurgents and warlords but also multinational corporations and international organizations.

For Africans, the lack of the state's institutional capacity is felt most keenly in the area of security. Police and other elements of the official security sector are generally absent, and when they do make an appearance, they are often themselves a major cause of insecurity. In many instances, this leads African communities to organize their own protection. Vigilante groups, militias, and other nonstatutory paramilitary groups can be found in most African states. As a result, many African central governments can no longer be exclusively or even largely responsible for national security. Security sector fragmentation presents a number of challenges for African states, external powers, and others operating on the continent. It is difficult to see how this process can be reversed in Africa.

A New U.S. Military Strategy in Africa

What does the foregoing mean for the emerging U.S. military strategy in Africa? According to the PAF study, the principal tenet should be to have modest expectations. It is important to recognize that American policy and actions cannot transform Africa's broken systems. It is equally important for the United States to avoid taking any action that will make it harder for Africans to fix such systems themselves. A U.S. strategy should seek to keep cost and benefit in careful balance by taking

A Malian boy stops to watch incoming CV-22 Ospreys carrying Malian and Senegalese troops during an exercise near Bamako, Mali. U.S. special operations forces worked with African and European partner nations to build bonds of trust and confidence.

a limited-objectives, limited-liability approach that emphasizes the indirect application of American military power.

It also means that U.S. Africa Command will need to develop the expertise and relationships necessary for dealing with the complexity of the African security environment. U.S. armed forces are today still designed largely for high-intensity operations. However, there are very few scenarios in which the expected value of an intervention in Africa would be worth the immense costs of a conventional warfighting operation. It will take many years to develop African specialists, foster relationships with African partners, and help build the partners' capacity. However, without this investment, U.S. military involvement in African conflicts will often be ineffective, if not actively counterproductive.

The Air Force Will Play a Central Role in Implementing U.S. Strategy

The tyranny of distance will likely cause the Air Force to operate in ways that it has not operated in Africa before and in ways that it does not operate anywhere else. The study recommends that the Air Force focus its efforts on five priorities in the near term: establishing positive, personal relationships with African air actors; building the capacity of key African partners; providing operational support to key African partners; preparing to conduct a limited set of steady-state joint operations in Africa; and improving U.S. posture in and around the continent. The study also

Adam Grissom

Adam Grissom first encountered RAND while he was growing up in Bettendorf, Iowa, a small town on the Mississippi River. "As a kid, I was fascinated by things like the Soviet Army's order of battle and the latest modifications to the MiG-27. I could usually be found with my head buried in a copy of *Jane's* or a RAND report. From reading some of the RAND greats, like Paul Davis and Richard Kugler, I knew that civilian defense analysts could make a contribution. It seemed like a natural path for me to follow." He went on to earn a master's degree in public policy at Harvard's Kennedy School of Government and a doctorate in war studies at King's College London. During the 1990s he served on the Balkans Task Force and several other directorates in OSD. Having walked in an action officer's shoes over the course of 18-hour work days, he is mindful of the need to maximize the policy relevance of RAND research.

Since coming to RAND in 2000, Adam has led more than a dozen major studies in such areas as defense strategy, force planning, and security cooperation. His work consistently draws on analyses about the capabilities needed to combat irregular adversaries indirectly by building the capacity of partner nations. "The tools of the indirect approach—training, equipping, advising, and assisting partners—are much less costly to employ than conventional assets," he explains. "And when they are committed early on, they can function as preventive medicine, helping weak states improve their 'resistance' to terrorism." In 2006, Adam received RAND's Gold Medal Award for his body of work on indirect operations, an approach that DoD has moved to embrace. "I'd like to think we contributed to that," Adam says.

> Interacting with operators in the field is by far the best part of this job. It is fascinating and humbling to witness the efforts of our airmen, soldiers, sailors, and marines.

Asked about the highlights of his RAND career, Adam replies without hesitation. "Interacting with operators in the field is by far the best part of this job. It is fascinating and humbling to witness the efforts of our airmen, soldiers, sailors, and marines." In addition to his experiences in Africa, Adam has also been in the field in Iraq and in Afghanistan, where he recently spent several weeks studying Afghan Army tactics in Helmand, Uruzgan, and Ghazni provinces. He says that it was "an enormous privilege to learn from these guys and to have the opportunity to try to help them."

Back home in Virginia, Adam collects books and confesses to being a rabid fan of Iowa Hawkeyes football. "But at this stage, I'm too busy being a dad to have any of my own hobbies. My five-year-old daughter, Ellie, loves to go to the National Mall on weekends—visit the Smithsonian museums, ride the carousel, and kick a soccer ball around in front of the Capitol. So those are my hobbies now, too." He and his wife, Sarah, welcomed their second daughter, Beatrice Louise, in September.

Fortunately, a sabbatical of sorts will keep Adam a bit closer to home in the near term. This fall, he will reduce his commitments at RAND to become a full-time visiting professor of security studies at Georgetown University. Then, in May 2011, he will return to RAND to resume his research activities. Adam is looking forward to the change. "It's quite common for RAND analysts to move among academia, government, fieldwork, and back to RAND. Our ability to bridge these communities is one of the things that make us unique."

proposed 15 initiatives to operationalize these priorities, including the following relationship- and capacity-building actions:

- Establish an African air university, collocated with the 17th Air Force and managed in cooperation with the African Union. The university would aim to double the number of American-trained African air force students to 300 per year.
- Establish two dedicated squadrons—one aligned with Special Operations Command Africa, the other with the 17th Air Force—to support the ability of partner states to extend sovereignty and governance over their territories through foreign internal defense aviation operations.
- Offer to send liaison officers to the air components of key United Nations, African Union, and European Union operations on the continent and to key African air force commands. The liaison program would ensure an effective flow of information among the key military air actors in Africa and provide in-depth insight into the workings of host organizations.

Finally, the Air Force will provide airlift; personnel recovery; intelligence, surveillance, and reconnaissance; and kinetic support to joint forces and indigenous partners in key regions of the continent. To help ensure that the Air Force is postured to meet these requirements effectively, the PAF team recommended a series of adjustments to the U.S. presence in and around Africa. The result would be a distributed set of low-profile Air Force locations, called *flex-hubs*. Their primary purpose would be to create the physical infrastructure to support short, small-scale air operations, such as security force assistance and humanitarian relief, but they would also be valuable for building lasting relationships with the host nations. The hubs would involve multiple bare bases in different states within key regions, each to be reachable from existing main operating bases via distinct air routes. Flex-hubs would therefore provide a variety of basing and overflight options that could be adjusted to respond to volatility in African partner governments or perturbations in the bilateral relationship between a host nation and the United States. PAF researchers found that this type of distributed and flexible posture is more appropriate to African realities than the traditional approach of establishing a long-term fixed posture within the region.

The African environment is austere and complex. But through such actions as those described above, the Air Force can help shape policy in important ways in a region of increasing significance to the United States.

The tyranny of distance will likely cause the Air Force to operate in ways that it has not operated in Africa before and in ways that it does not operate anywhere else.

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Modernizing the KC-10 Extender Tanker Fleet

What Are the Most Cost-Effective Options?

A KC-10 Extender from the 908th Expeditionary Aerial Refueling Squadron refuels a Navy F/A-18 Super Hornet over Afghanistan. Using either an advanced aerial refueling boom or a hose-and-drogue centerline refueling system, the KC-10 can refuel a wide variety of U.S. and allied military aircraft during the same mission.

The Air Force's KC-10 Extender is an advanced aircraft designed to enhance global mobility for the U.S. military. The tanker's primary mission is aerial refueling, which requires a crew of four. The KC-10 is also capable of transporting up to 75 people and nearly 170,000 pounds of cargo for distances of about 4,400 miles without itself having to refuel.

The Air Force's KC-10 tanker fleet, currently comprising 59 aircraft, has operated since 1981 without significant modernization. However, the service is now considering several modernization options that it asked PAF to assess. One set of options would allow tankers to operate closer to the mission areas of receiver aircraft than is currently possible. Reducing the distance receiver aircraft must fly to refueling locations would shorten cycle times and conserve fuel. Another type of modification would help speed up the refueling process itself. Both approaches would improve the operational efficiency of the fleet, thereby enabling tankers to perform the same missions using less fuel, provide additional fuel to the receivers, or both.

Adding defensive systems and data links to the KC-10s would allow them to traverse more-dangerous environments than they can today by providing added protection against threats and by giving the crew a better understanding of what is going on in the airspace around the aircraft. Moreover, tankers with data link equipment could act as relays for other aircraft that are flying at lower altitudes and whose communications are limited by line of sight.

Finally, there are opportunities to exploit the substantial cargo-carrying capacity of KC-10s and increase their use as airlifters. Thus, the Air Force would gain the substantial flexibility that aircraft capable of dual roles provide.

PAF Analyzed Five Modernization Options Using a Representative Set of KC-10 Wartime Missions

In this study, the PAF research team assessed the cost-effectiveness of modernization options in five areas: avionics (communications, navigation, and surveillance capabilities for air traffic management), night-vision imaging systems, a command-and-control tactical data link, additional multipoint refueling capabilities, and defensive system upgrades.

The team estimated the total life-cycle cost for each option and compared that cost to the quantitative benefit of the option. The basis for the benefit calculation was how many tanker aircraft the increased wartime mission effectiveness "saved." Researchers also used 11 years of operational KC-10 flying data to estimate how modernization affected peacetime operating costs.

Upgrading the tanker's communications, navigation, and surveillance capabilities for air traffic management will give it access to the most fuel-efficient altitudes.

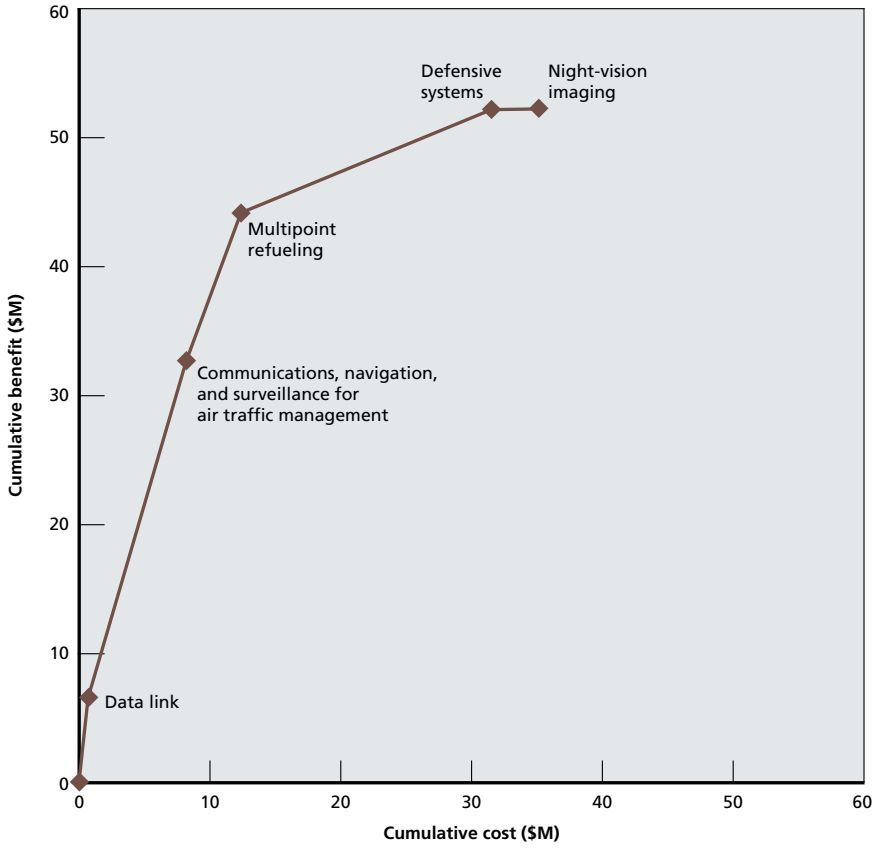
To evaluate the effects of modernization on warfighting capability, PAF modeled four representative wartime missions for the KC-10:

- The *homeland defense* mission was to provide aerial refueling to fighter aircraft conducting defensive combat air patrols over the United States and to Airborne Warning and Control System aircraft conducting radar surveillance of national airspace.
- The *theater employment* mission was to support a major combat operation from four aerial refueling locations.
- The *deployment* mission was to help fighters deploy from home base in the continental United States to an overseas location they could not reach without aerial refueling. This mission required continuous refueling of the fighter "package" during its entire flight up to the point where the fighters had enough fuel to reach their destination.
- The *air bridge* mission was to extend the range of large aircraft through a single, substantial refueling rather than through the continuous escort of the deployment mission. For the PAF study, this category also included the global strike, national reserve, and global deterrence and strike mission areas.

Of the Five Options, Three Are Cost-Effective, One May Be, and One Is Not

After examining the costs and benefits of each of the modernization options individually, the research team compared their relative merits by ranking them according to their cost-effectiveness ratios—the ratio of improvement in wartime effectiveness plus any change in peacetime operating cost that resulted from the cost of the upgrades. The results of this analysis are described below, in order of the degree of benefit they confer.

SSgt Nichole Smith, a guidance and control specialist with the 380th Expeditionary Aircraft Maintenance Squadron, ensures that the computer system in the avionics bay of a KC-10 Extender is working properly. KC-10 maintainers keep the missions flowing in a deployed location in Southwest Asia.



Total Expenditures and Expected Benefits for the Modernization Study

Adding a tactical data link to the KC-10s is the most cost-effective of all the options. The data link is a relatively inexpensive upgrade that would give the tankers position and mission information about receiver aircraft without the need for voice communication. This, in turn, would reduce planned overlap times and facilitate faster rendezvous with receiver aircraft.

Modifying the KC-10 avionics has the next highest effectiveness ratio. Upgrading the tanker's communications, navigation, and surveillance capabilities for air traffic management will give it access to the most fuel-efficient altitudes. This upgrade is cost-effective under a broad range of fuel cost and other assumptions. Even under a worst-case cost scenario, the savings from this modernization option would exceed the cost of the upgrade long before the fleet is retired in 2045.

Additional multipoint refueling capabilities increase effectiveness primarily in the employment mission, when tankers can refuel multiple strike and air defense aircraft. For the mission mixes in this study, researchers considered six, eight, and 12 receivers per tanker. They found that there is also a benefit for the deployment mission, but it is somewhat lower.

Defensive system upgrades are cost-effective only if they allow basing the KC-10s significantly closer to wartime operational aerial refueling locations than planning documents currently specify or than has been the practice in recent conflicts. The upgrades may also

Anthony Rosello

Anthony Rosello knows a lot about cargo aircraft, and not only from conducting research. Before coming to RAND in 2005, he spent 11 years in the Air Force, most of it piloting C-5s and C-21s. That story started back in 1985. "I had been fascinated by astronauts and pilots since I was a little kid. When I was in the eighth grade, I found out there was an Air Force Academy, and I decided that, no matter what I did in life, it was going to be with airplanes, space, or missiles." He also knew that he had to be nominated for the academy, so when the congressman for his district was in town, Anthony paid him a visit. "He told me to come back in three years. But from that time on, I considered just about everything I did in terms of how it would look on my application."

Anthony made it to the Air Force Academy. In 1993, he was named both outstanding cadet in engineering sciences and distinguished graduate. Now a second lieutenant, he spent the next two years at the Massachusetts Institute of Technology, where he was awarded a master's degree in aeronautical and astronautical engineering. A year of pilot training followed, then four years as C-5 Galaxy aircraft commander and air mobility director. His duties ranged from participating in humanitarian relief operations to solving C-5 wheel brake maintenance problems to developing software for presenting current mission and manpower tasking data to higher Air Force commands. He concluded his Air Force career as flight examiner, chief of Standardization and Evaluation, and assistant director of operations for the C-21 Learjet. In these roles, he flew theater airlift missions in Operation Iraqi Freedom and developed, taught, and supervised training programs.

> When I was in the eighth grade, I found out there was an Air Force Academy, and I decided that, no matter what I did in life, it was going to be with airplanes, space, or missiles.

PAF's Force Modernization and Employment program has been a perfect fit for Anthony. For the past five years, he has applied his skills as a technical and operations expert to such topics as upgrading legacy fighters; enhancing intratheater airlift capabilities; extending the life of the C-130 Hercules transport fleet; and ensuring the availability of positioning, navigation, and timing data to the warfighter. Most recently, he led a research effort to analyze the cost-effectiveness of several options for modernizing the KC-10 aerial refueling aircraft. He has also assumed a corporate role as co–group manager of RAND's Technology and Applied Sciences group, which focuses on hiring and developing staff with skills in mathematics, science, engineering, and other technology-related fields.

However, Anthony hasn't given up his flying career. He serves in the Air Force Reserve and, in 2009, took a leave of absence from RAND to be trained as a C-130 Hercules pilot. He is also a licensed commercial pilot with multiengine and instrument ratings.

Whatever free time he can find, Anthony devotes to his family life. He and his wife, Stacy (an occupational therapist) have three children: Grace, age 12; Kate, age 10; and Andrew, age 6. When he accepted RAND's job offer, the family started house hunting. "We were looking at a particularly nice home on a large lot, and I told the kids that, if we get this one, I'd build them a tree house." They did get it, and he took vacation time during the summer to make good on his promise. "Life at the Rosello house is busy, but it's never boring," he says, "just like working at RAND."

A KC-10 Extender from Travis Air Force Base, California, refuels an F/A-22 Raptor, the replacement for the F-15 Eagle. The Raptor, the most advanced fighter aircraft in the world, is a revolutionary leap in technology and capability over its predecessor but requires less support and costs less to maintain. The F/A-22's integrated avionics give it first-look, first-shot, first-kill capabilities that will guarantee U.S. air dominance for decades.

be cost-effective if they allow more-frequent use of KC-10s as airlifters, thus freeing a number of large airlifters already equipped with defensive systems—C-17s or C-5s, for example—to conduct other missions for which they are best suited. Where basing location is concerned, trade-offs can be made between the cost and extent of the upgrades and how close the military is willing to base the aircraft to areas of operation. As mentioned above, decreasing the distance between the tanker base and the refueling locations makes the aircraft more effective but may also place them in harm's way. Researchers assumed that, by adding the proposed suite of defensive systems, the KC-10s could be based 200 nautical miles closer to air refueling orbits. If true, the cost of the upgrade was higher than the value of its benefits.

Retrofitting the KC-10 with night-vision-compatible lighting is not cost-effective because the change in tanker effectiveness was minimal. The Air Force's testing and empirical safety data support this conclusion.

The graph on page 29 illustrates these modernization options in a cumulative plot of total expenditures and expected benefits. In summary, for data links, avionics, and multipoint refueling capabilities, the benefits exceed the cost. The reverse is true for defensive systems and night-vision lighting. However, taken as a package, if the Air Force decides to pursue all the upgrades, the overall benefits will exceed the overall costs.

FOR MORE INFORMATION, SEE

Upgrading the Extender: Which Options Are Cost-Effective for Modernizing the KC-10? by Anthony D. Rosello, Sean Bednarz, David T. Orletsky, Michael Kennedy, Fred Timson, Chuck Stelzner, and Katherine M. Calef, TR-901-AF, forthcoming.

Supporting Air Force Families

Understanding the Difficulties, Solving the Problems

SSgt Adam Yeo hugs his family at Misawa Air Base, Japan. Sergeant Yeo, a 35th Maintenance Squadron phase crew chief, had just returned from a deployment to Joint Base Balad, Iraq. The Air Force is seeking ways to deepen its support of families throughout the deployment cycle, particularly with regard to the needs of children.

By designating July 2009 to July 2010 as The Year of the Air Force Family, the Secretary of the Air Force and the Air Force Chief of Staff acknowledged both the crucial importance of the family unit in Air Force life and the need to enhance organizational support for families. Four areas are of particular concern to Air Force leaders:

- the types and causes of problems Air Force families face
- whether Air Force support programs successfully help families cope with these problems
- families' perceptions about Air Force leadership
- their overall satisfaction with Air Force life.

As part of an information-gathering effort, the Air Force Deputy Chief of Staff for Manpower and Personnel and the Airman and Family Services Branch asked PAF to survey spouses of a representative sample of married active-duty airmen (enlisted personnel and officers). Administered in summer 2009, the survey focused primarily on child-related, employment-related, and financial problems these families had faced during the previous year. The principal findings are reported below.

Many Survey Respondents Reported Child-Related Problems

Over one-half of parents—37 percent of all spouses surveyed—reported at least one child-related problem. The two most common were the difficulty of finding child care and children's development of emotional and/or behavioral problems. Among families with children and at least one parent recently deployed, more than one-half reported that the deployment worsened child-related problems; very few indicated an improvement. Among the factors the respondents thought contributed to their child-related problems were permanent changes of station, the spouse's work schedules, and the hours Air Force child care was available. Finally, at least 10 percent of the respondents also linked their problems to their distance from Air Force activities for children or from Air Force day care or to the limitations of Air Force programs intended to address child-related problems.

Employment-Related Problems Were Similarly Prevalent

Among the spouses of airmen, 37 percent had had employment problems. The problems cited most often were difficulty finding a job that would allow them to work a preferred schedule or number of hours and simply finding a job, especially one appropriate to the respondent's level of education, abilities, and interests. About 16 percent found it difficult to obtain education or training to enhance their career development. For spouses who had faced at least one employment challenge and a recent deployment in the family, nearly one-half reported that their situation worsened during the deployment, while only 9 percent reported an improvement.

The problems cited most often were difficulty finding a job that would allow them to work a preferred schedule or number of hours and simply finding a job, especially one appropriate to the respondent's level of education, abilities, and interests.

Other specific factors commonly associated with spouses' employment problems were recent permanent changes of station and the difficulty of finding a job that paid enough to cover the costs of child care or of finding child care that matched working hours. Nearly one-third of the spouses with employment problems reported a lack of information about Air Force employment assistance programs, inconvenient access to the programs, or the inability of the programs to address particular issues.

Financial Problems Were Less Common

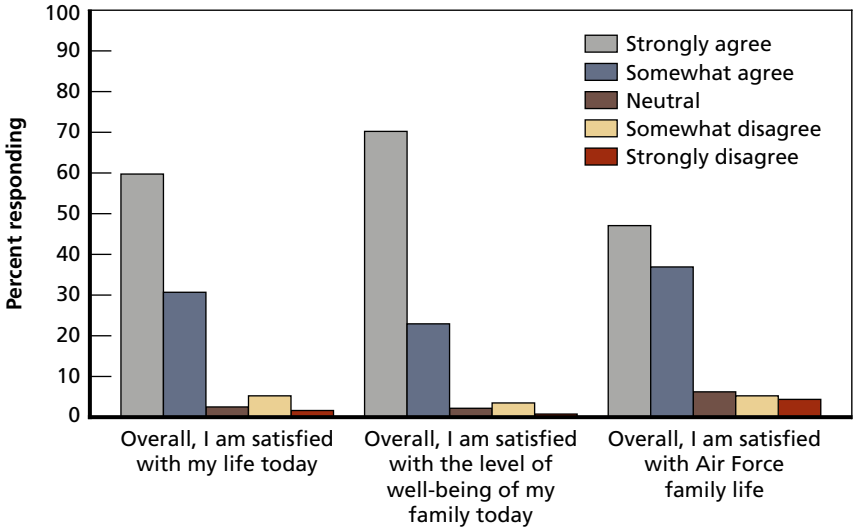
The good news is that, despite the economic downturn and the housing market collapse of 2008, fewer than one-third of spouses reported facing any of the financial problems mentioned in the survey. The most common financial problem, cited by 25 percent, was the inability to save, while fewer than 10 percent of spouses indicated that they had trouble paying the mortgage or other recurring monthly bills, reducing credit-card debt, etc. The most severe financial problems—home foreclosure and bankruptcy—were rarely reported, with fewer than 1 percent of respondents saying that either had occurred in the past year.

Financial problems were most frequently associated with the costs of raising children, spousal employment status, and recent relocations. Notably, nearly one-third of those with financial problems reported a lack of information about Air Force financial education programs. Somewhat smaller numbers cited inconvenient access to such programs or the inability of the programs to address their specific financial problems.

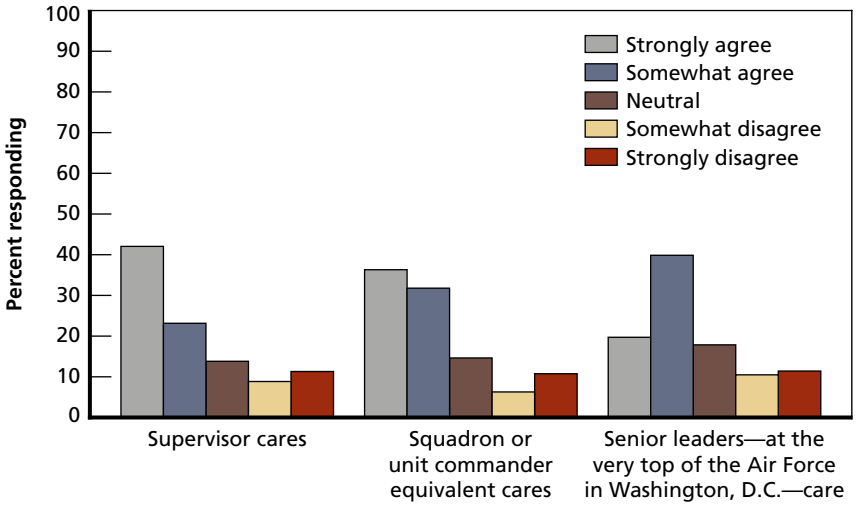
Deployment Services Received Mixed Reviews

Air Force deployment support services seek to mitigate the negative effects of deployments as much as possible. Forty-five percent of spouses whose family had experienced a recent deployment rated these services

Gen Roger Brady, commander of the U.S. Air Forces in Europe, shakes hands with Hunter Koltes, 13, at Ramstein Air Force Base, Germany. On April 21, 2010, General Brady announced that Hunter had won the Year of the Air Force Family video competition. Hunter received the general's congratulations, a $2,000 gift check toward the purchase of a computer and video camera, and a commander's coin for his tribute video called, "Life of a Military Brat."



Spouses' Overall Satisfaction with Their Personal and Family Lives and with Air Force Family Life



Spouses' Perceptions About Whether Air Force Leadership Cares About Family Well-Being

as "good" or "excellent." However, nearly 20 percent rated them as "fair" or "poor." Another 20 percent of spouses who had experienced a recent deployment were unable to rate deployment services at all—i.e., they responded that they did not know or that services were not offered.

Respondents Reported High Satisfaction with Air Force Life and Generally Positive Perceptions of Leadership

Taking into account the problems noted above, over 90 percent of spouses nevertheless reported satisfaction with their lives and their family's well-being (see upper chart). Furthermore, over 80 percent were satisfied with Air Force family life and indicated that their families were likely to remain in the Air Force for another tour of duty.

The majority of respondents also believe that Air Force supervisors, unit leaders, and senior Air Force leadership care about Air Force family well-being (see lower chart).

SSgt Corodney Hunter holds his daughter, Jamari, at a security forces homecoming ceremony at Moody Air Force Base, Georgia. Deployed members from the 820th Security Forces Group, 23rd Security Forces Squadron, returned home early from their deployment to spend the holidays with family and friends.

The Air Force Could Enhance Its Efforts to Support Families

The findings of this survey suggest several courses of action to provide additional support to Air Force families. The PAF research team recommends that the Air Force expand its assistance with family relocations to minimize disruptions to spousal employment, family finances, and child well-being. Similarly, Air Force leadership could deepen its support to families throughout the deployment cycle, particularly with regard to the needs of children and the associated employment challenges for civilian spouses.

Improved communication about financial and employment assistance programs would link a greater number of families in need to resources already available to support them. The Air Force could enhance employment opportunities for spouses by developing partnerships with national companies and Air Force contractors.

Planned efforts to increase the availability of child care will help address some of the difficulties Air Force families with children now face. Expanding and better publicizing youth activities available after school and on weekends will also help fill a need that spouses of active-duty personnel have identified.

Finally, to publicize Air Force programs and services, the PAF team recommends using spouses' preferred means of communication, which include emails and Air Force newsletters, newspapers, and websites.

FOR MORE INFORMATION, SEE

Year of the Air Force Family: 2009 Survey of Active-Duty Spouses, by Laura L. Miller, Sarah O. Meadows, Lawrence M. Hanser, and Stephanie L. Taylor, TR-879-AF, forthcoming.

Laura Miller

RAND social scientist Laura Miller has always sought opportunities to meet service members in their "natural habitats." During her 18-year career, she has conducted interviews, surveys, focus groups, and observations at more than 30 military bases in the United States, as well as in operations in Kuwait, Qatar, South Korea, Germany, Somalia, Haiti, Macedonia, Bosnia, and Afghanistan.

"Meeting military personnel where they live and work gives you an appreciation for the physical and social challenges they confront, as well as the camaraderie and personal bonds they form while working together, often in austere conditions. It's hard to imagine or appreciate all that from afar."

Laura earned master's and doctorate degrees in sociology at Northwestern. She became interested in the military while working as a graduate student with the late Dr. Charles Moskos, then the nation's preeminent military sociologist. Her dissertation focused on gender integration in the U.S. Army. Following a two-year postdoctoral fellowship at Harvard, Laura spent five years as an assistant professor of sociology at UCLA. Then, in 2002, she joined RAND. As she explains, "Although I enjoyed teaching, I really wanted to devote my time to conducting research and providing findings and recommendations to decisionmakers. After interviewing people who share some of their most important life concerns with me, I feel obliged to try to make a difference." However, as a faculty member of the Pardee RAND Graduate School, Laura has continued to mentor students.

During her career, Laura has addressed such issues as military culture and organization, civil-military relations, social integration in the military, and the effects of deployments on service members and their families. Her latest study focuses on Air Force civilian health and well-being. That work is being sponsored by the Air Force Materiel Command, nearly 75 percent of whose personnel are civilians. In recognition of her ongoing research contributions to the Air Force, Laura received a 2010 Research Excellence Award from PAF.

Laura has also served on a number of advisory boards and congressionally mandated task forces and commissions. For example, in 2008–2009, she added a sociological perspective to Army efforts to examine increasing suicide rates among soldiers. In 2009 and 2010, she participated in OSD and Air Force reviews conducted after an Army officer carried out a mass shooting at Fort Hood, Texas. The broad mandate of these studies was to evaluate DoD's ability to detect, prevent, and respond to a wide range of violent threats from inside the military community.

"Science still has a long way to go before it can predict who is likely to become violent toward themselves or others," she says. "In the meantime, we can focus on supporting personnel in distress and providing commanders with the best tools available to help them identify and remove internal threats."

Meeting military personnel where they live and work gives you an appreciation for the physical and social challenges they confront, as well as the camaraderie and personal bonds they form while working together, often in austere conditions.

The New Cyberwarriors

Managing Human Capital for the U.S. Air Force Cyberforce

SrA Scott Everett, a computer, cryptographic, and switching systems technician, ensures that voice and data are working during a communications exercise at Homestead Air Reserve Base, Florida. The exercise was designed to familiarize troops from reserve, guard, and active military units with equipment they do not normally use.

In late 2006, the Secretary of the Air Force and the Air Force Chief of Staff formally extended the Air Force's "fly and fight" mission into cyberspace. Two years later, the service activated the 24th Air Force as part of Air Force Space Command to provide combat-ready forces trained and equipped to conduct sustained offensive and defensive operations in this global information environment, which includes the Internet, telecommunications networks, computer systems, and other information technology infrastructures.

The Air Force asked PAF to identify and analyze the human capital management issues associated with this new mission area. The research addressed four questions relevant to creating a sustainable cyberforce:

- What kinds of capabilities must it provide?
- How will it be distributed within Air Force organizations?
- What skills should it possess, and where should they be located across the Air Force rank structure and within current functional communities?
- What kind of military specialty classification structure and force management policy will lead to a technically proficient, operationally relevant, sustainable force?

PAF Undertook a Strategic Review of the Air Force's Envisioned Cyber Capabilities

The study team gathered data and information from current doctrine, strategic planning documents, and Air Force manpower databases. PAF researchers also conducted an extensive series of interviews with career-field managers and with senior leaders and staff responsible for current cyber- and information-operations capabilities.

One of the goals of PAF's information-gathering efforts was to clarify the capabilities that the Air Force intends to enhance or develop in its cyberforce in the near term and over time. This review led to two primary findings. First, the Air Force's concepts about flying and fighting in cyberspace focus tightly on network warfare operations and electronic spectrum operations that can integrate with current and future kinetic capabilities. In warfighting, cyber capabilities will either serve as a standalone nonkinetic strike function or work in concert with kinetic capabilities, operationally integrated through a global air operations center. In the latter case, success will depend on the functional integration of these capabilities with existing information operations and air and space capabilities. At the time this research was conducted, however, the Air Force had not specified how this integration would take place or what effects were expected to result from it.

The second finding addresses external issues. The Air Force is not alone in developing capabilities to operate effectively in cyberspace. Similar efforts are under way in the Army and Navy and in several defense agencies. But again, at the time of the study, there was no evidence that substantive planning was under way to integrate cyber capabilities among

the various organizations that expect to provide similar or complementary capabilities for creating and delivering cyber effects.

In warfighting, cyber capabilities will either serve as a stand-alone nonkinetic strike function or work in concert with kinetic capabilities, operationally integrated through a global air operations center.

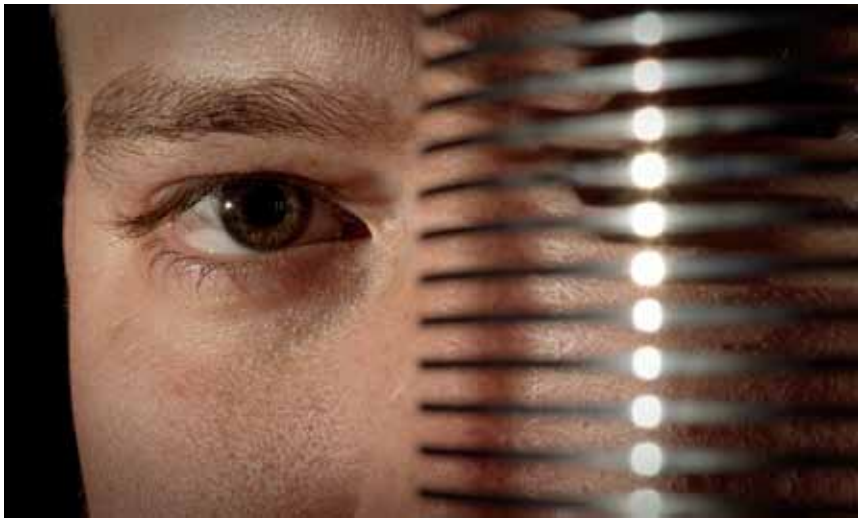
The Supply of Personnel with the Right Skills for the Cyberforce Is Limited

The organizations the study team analyzed have two basic position types. The first requires skills from traditional specialties—e.g., communications, computers, intelligence, developmental engineering, and electronic warfare operations. The second type augments the traditional skills with specific capabilities, such as network warfare operations, network analysis, knowledge of cyber threats, hacking methodology, computer network exploitation tools, information operations, and electromagnetic spectrum knowledge. Thus, the latter set of positions has "cyber-hybrid" requirements for officers, enlisted personnel, and civilians.

Most airmen are developed for the cyber-hybrid jobs through organizationally specific on-the-job training programs. This approach produces just-in-time skills for just enough personnel. PAF researchers estimate, however, that about 2,600 cyber-hybrid jobs currently exist throughout the Air Force, making it unlikely that a decentralized, organizationally specific development approach will be enough to build a sustainable workforce. Consequently, more-aggressive human capital management strategies are needed to increase the pools of highly skilled talent necessary for computer network defense, attack, and exploitation.

Air Force Specialty Codes Could Be Refined to Help Manage the Cyberforce in the Near Term

To help manage its human capital, the Air Force uses a basic code to keep track of capabilities and pertinent experience—and for matching them to the jobs needing the combinations these various airmen have. Each number and letter in an individual's Air Force Specialty Code (AFSC) adds a layer of information about his or her career track, skills, experience, training, etc. The standard code is not always flexible enough to fit



Jon Beasley peers through a disk platter stack at the Defense Computer Forensic Laboratory in Linthicum, Maryland. The image and extraction technician makes disk images of computer memory storage devices.

Communications and information specialists like SrA Kenneth Hawkins and A1C Ryan Gall, seen here testing wires for a dial tone in Iraq, will soon find that their job requirements are changing as the Air Force proposes 15 new cyberspace career fields. These voice systems technicians are just two of the approximately 30,000 active-duty members the changes will affect.

all supply-and-demand combinations, such as those of the cyberforce. To further clarify in such situations, there are five additional specialty-related mechanisms:

- *AFSC prefixes* are letter designations that identify an ability, special qualification, or system. For example, an *E* denotes electronic combat support duty; a *U* denotes information operations. These are the two most directly applicable to cyber skills at present.
- *AFSC suffixes* are letter designations that specify skill subsets related to equipment or functions and positions within an AFSC.
- *Accession-entry AFSCs* are designed for those who have had sufficient prior training or education to merit entry directly into a high-demand career field soon after induction into the Air Force, once they have completed requisite training or certification. This option is a function of the number of positions requiring common qualifications and skills that are distinct from other specialties and the amount of training or education considered sufficient for entry into the specialty.
- *Lateral AFSCs* are typically awarded to personnel who have qualified previously in a related AFSC. In the cyberforce, these codes could be used to systematically identify specific cyber-hybrid skills among experienced personnel in related specialties.
- *Special experience identifiers* indicate work experience or training that the system does not otherwise record. However, personnel processes do not use these identifiers routinely, and they do not substitute for AFSCs.

The PAF team concluded that the most effective immediate action the Air Force can take to build cumulative cyber experience is to customize accession-level AFSCs, lateral AFSCs, and AFSC suffixes for the major Air Force specialties that contribute to cyber missions.

The Rapid Evolution of Concepts of Operation Means Continuous Evaluation of the Skill Requirements

To characterize the ways in which the skill requirements might evolve, PAF constructed a scenario for cyber capabilities in 2020. This scenario proposes fully integrating these capabilities with conventional kinetic operations. Cyber operations will be part of wide-ranging missions against traditional nation-state and irregular adversaries and will be employed, both offensively and defensively, across the spectrum of military and nonmilitary threats.

By 2020, the Air Force will have developed cyberwarriors with complex skill sets that meet the National Security Agency's standards for conducting a complete portfolio of network operations. These airmen

SrA Ryan Albert installs computer systems in the new 497th Intelligence, Surveillance and Reconnaissance Group building at Langley Air Force Base, Virginia. Airman Albert is an electrical power production journeyman with the 10th Intelligence Squadron.

will possess complementary knowledge in air and space operations; information warfare; psychological operations; strategic communications; and interdependence and synergies among network attack, defense, and exploitation.

Recommendations to the Air Force

The Air Force can take several concrete steps to manage its cyberwarriors:

- Establish a more-comprehensive concept of operations that addresses the functional, organizational, and operational integration needed to create highly valued capabilities and that provides guidance about how the Air Force will operate in cyberspace throughout the peace-war-reconstitution spectrum of activities.
- Use the revised concept of operations as a basis for stakeholders to specify total-force human capital requirements for active-duty and reserve components, civilians, and contractors. Developing more-comprehensive specifications for cyber operations will add precision to the Air Force's specification of the cyber-based skills needed in the force, its classification structure for cyber skills management, and its identification of the best combination of sources for acquiring these skills within the total force.
- Establish a lateral officer AFSC as a way to manage cyber skills, particularly for policy, doctrine, planning, and programming jobs that demand great familiarity with all things cyber. Use AFSC suffixes to manage cyber skills within other officer specialties.
- Continue efforts to retool the enlisted communications-computer specialty into an accession-entry cyber specialty. Use suffixes and special experience identifiers to manage cyber skills in other specialties, such as intelligence.
- Continuously assess the sustainability of the cyberforce. At the time this research was conducted, the force structure for cyber personnel had not been completed, and targets for types of manpower, specialties, training, and grade-skill mixes had not been fully specified. Once these activities are concluded, the Air Force can begin to determine whether or not its supply of human capital falls short of the desired targets and respond by developing the accession, utilization, and retention policies that are necessary to maintain the viability of the cyberforce.

Developing more-comprehensive specifications for cyber operations will add precision to the Air Force's specification of the cyber-based skills needed in the force.

FOR MORE INFORMATION, SEE

Human Capital Management for the USAF Cyber Force, by Lynn M. Scott, Raymond E. Conley, Richard Mesic, Edward O'Connell, and Darren D. Medlin, DB-579-AF
http://www.rand.org/pubs/documented_briefings/DB579/

Raymond E. Conley and Lynn M. Scott

We learned that leaders without domain knowledge have a small subset of competencies—for example, elaborate communication skills that improve interactions, people skills that go beyond merely being personable—that still produce great insights into human performance.

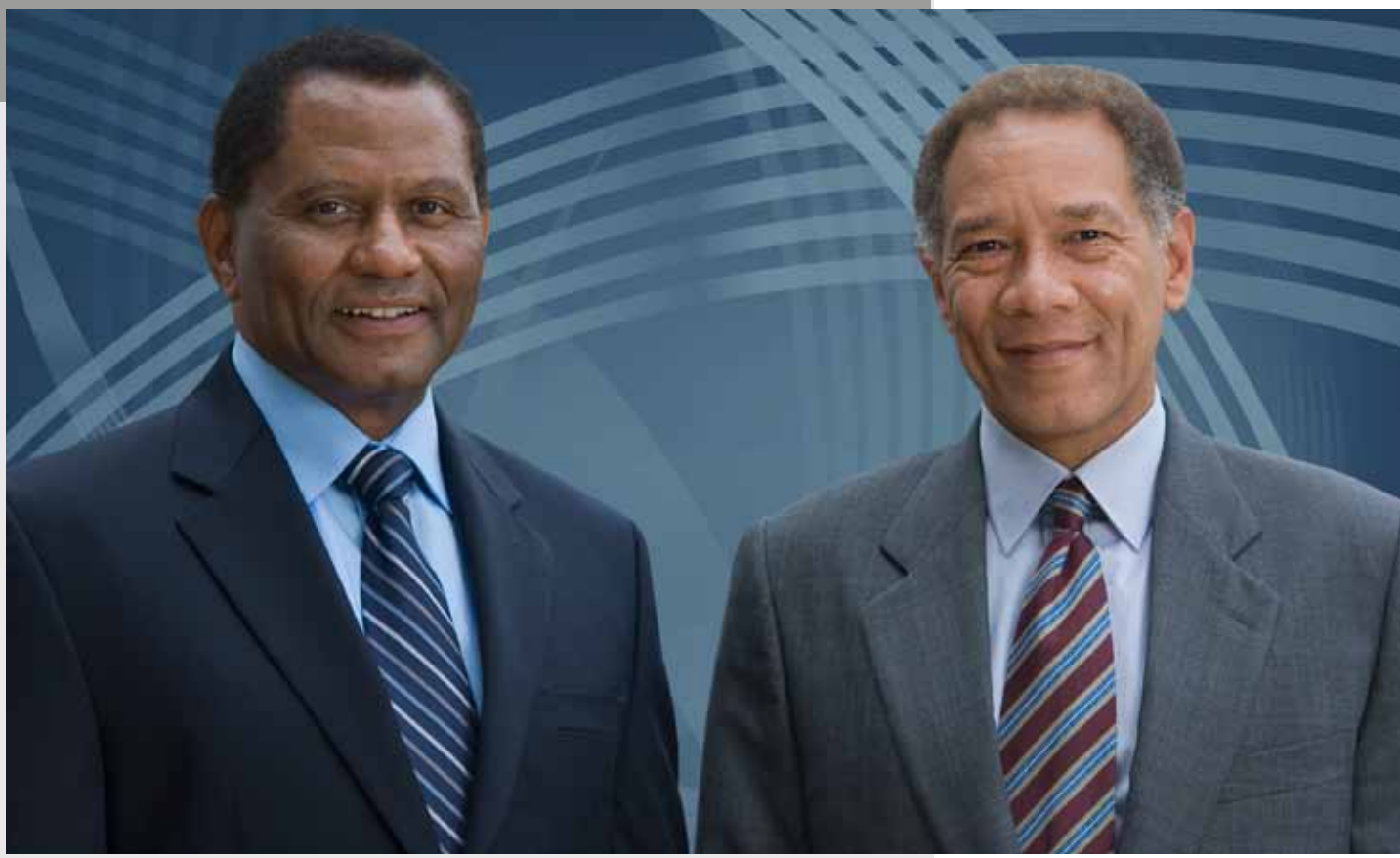
Choosing strategies that will produce a workforce of the right size, composition, and skills has never been more complicated, especially in the rapidly evolving world of cyberwar. "The answers change quickly now," says Raymond Conley, a senior management scientist at RAND, "and the Air Force can't wait several years for them." Since joining RAND in 2001, Ray and policy researcher Lynn Scott have teamed up periodically, starting with a project focused on leadership development in the Air Force. Between them, they have conducted a series of analyses that have offered the Air Force innovative strategies to address a wide range of manpower, personnel, and training issues, including the challenge of building a cyber workforce.

There are other interesting parallels in their lives. Ray and Lynn both received master's degrees in national resource management from the National Defense University, earned doctorates, taught courses on leadership development, and joined RAND after long careers in the Air Force. Nevertheless, they brought distinct professional experiences—and talents—with them. Ray specialized in manpower issues and, as a manpower manager, he was a practitioner in his field. Lynn specialized in personnel management, and his Air Force career centered on research. Even a shared love of music finds them in different parts of the orchestra, with Ray as a pianist and Lynn a flautist.

En route to receiving his doctorate in public administration from the University of Alabama, Ray earned two more master's degrees, one in business administration and the other in industrial engineering. As chief of the Manpower Requirements Branch at Air Force, Strategic Air Command, he helped plan and program for the B-1, B-2, Peacekeeper, small ICBM, modifications to the B-52, and several space platforms with their support systems. As a junior officer, he received the Air Force award for Outstanding Manpower Officer of the Year. Today, he works with the Air Force to activate its Global Strike Command and reinvigorate its nuclear enterprise.

Ray saw RAND as an opportunity to think a little more strategically about what the Air Force does and does not do well. "As a manager, you don't have a lot of opportunity to think about the underpinnings of decisions and how to make better ones in the future. You have to make a decision and then move on to something else." In a recently completed project, Ray and his colleague Al Robbert saw the opportunity to think about the underpinnings of the Air Force's system for classifying occupational specialties and to help change Air Force thinking about this system. Several senior Air Force leaders had asked whether the existing specialty-classification structure was appropriate, given the changing nature of modern warfare. The RAND study showed that the classification system was sound but also that guidelines were needed to address the changes that an evolving workforce would inevitably bring. By analyzing changes in the classification structure over time, Ray and Al were able to identify the factors that drove these changes and, from there, to lay out principles to guide manpower managers. These principles are now informing Air Force thinking about the evolving cyber workforce.

Lynn received a bachelor's degree in organizational behavior from the Air Force Academy, where he later taught courses on leadership theory in the Department of Behavioral Sciences and Leadership. He also earned a second master's degree in industrial psychology from St. Mary's University and a doctorate in management from the University of Texas at Austin.



When Lynn joined RAND, he saw it as a continuation of a career centered on research as an industrial and organizational psychologist. He started out in the Air Force as a research team leader at the Air Force Human Resources Laboratory at Brooks Air Force Base, where he was responsible for research in personnel attrition, productivity improvement, personnel selection, and executive development. Later, at the Armstrong Laboratory at Brooks Air Force Base, he led a team of scientists and technicians from different service branches and countries who sought ways to maintain training proficiency and productivity levels in the face of large-scale downsizing and attrition. As chief of Research Operations, Manpower and Personnel Research Division at the laboratory, he led efforts to improve Air Force manpower, personnel, and training programs. He concluded his Air Force career as a professor of behavioral science in the Industrial College of the Armed Forces at the National Defense University.

Throughout his nine years at RAND, Lynn's research has focused on identifying the knowledge, skills, and abilities executives need. The need for multiple areas of expertise; the emergence of new weapon systems, technologies, and operating environments; and the constraints of long-term career development strategies frequently cause the Air Force to assign senior leaders to positions for which they lack specific experience. One of Lynn's studies showed that when successful Air Force leaders find themselves in such positions, they draw on compensating competencies. "We learned that leaders without domain knowledge have a small subset of competencies—for example, elaborate communication skills that improve interactions, people skills that go beyond merely being personable—that still produce great insights into human performance." The study recommended that the Air Force develop these compensating competencies among its leaders and staff members to better prepare them for the greater variety of organizations and operating domains they may encounter in the future.

To Fund or Not to Fund

Assessing Capabilities and Risks in Air Force Programming

Airmen from the 49th Materiel Maintenance Group set up a small shelter system during an exercise at Holloman Air Force Base, New Mexico. Members of the group can set up Basic Expeditionary Airfield Resources (BEAR) in austere conditions anywhere in the world. These airmen maintain a constant state of readiness and can be tasked to support any DoD or Federal Emergency Management Agency humanitarian operation in addition to their primary duty, supporting combat operations.

One key way the Air Force expresses its policy goals is by deciding which programs to fund and then determining the financial resources necessary to support existing operational capabilities and develop new ones. The process for making these decisions is lengthy and complex. It is also vitally important, not just because a great deal of money is involved but also because the Air Force's ability to organize, train, equip, and provide air forces to meet its mission depends, in large part, on the quality and correctness of these choices.

In 2001, Secretary of Defense Donald Rumsfeld modified the DoD budgeting process to make it more responsive to an increasingly unpredictable security environment. The key change was to abandon the old approach, which focused on a specific, known set of threats, in favor of one that focused on developing a portfolio of capabilities that would enable the United States to prevail against a variety of potential adversaries.

In such an environment, the need to understand the effects of programming decisions in terms of operationally relevant measures is crucial. Yet as DoD's goals become more diverse, it is likewise more difficult for the services to explain precisely how a particular programmatic investment helps achieve a specific national security objective.

PAF Built a Framework for a Capabilities-Based Program

Beginning in 2005, the Deputy Chief of Staff for Logistics, Installations, and Mission Support asked PAF to conduct several studies designed to help the Air Force improve its approach to capabilities-based programming. In an early study, the research team developed a framework for that purpose and demonstrated how it could be used to guide programming decisions. The approach had four core attributes:

- The Air Force program objective memorandum should be constructed to provide maximum support to national-level planning objectives and should be presented to senior national security leadership in those terms.
- The method should be analytical, reproducible, and responsive within budgetary time frames.
- Capabilities must be linked directly to actual financial and manpower programming.
- The process should embrace the uncertainty of the future and should not be driven by specific combat plans. Furthermore, investments that reduce risk across a wide spectrum of threats should be favored over those that mitigate a small number of less likely threats.

As part of this research, PAF developed three algorithms for building a capabilities-based program objective memorandum for agile combat support equipment. The algorithms provided distinctly different insights into programming decisions. The first approach minimizes procurement and sustainment costs for meeting all requirements in a single-scenario set, subject to the constraint that spending is not allowed to fluctuate

more than a certain percentage from year to year. The second maximizes capabilities relative to a single-scenario set, given a fixed budget for each year. The third maximizes capabilities against a portfolio of possible futures simultaneously, subject to fiscal constraints. Only the third approach produces a robust program in the face of an uncertain future, thereby adhering to the spirit of current defense planning guidance. Thus, it is the one PAF advocates.

Investments that reduce risk across a wide spectrum of threats should be favored over those that mitigate a small number of less likely threats.

Two Case Studies Demonstrated the Feasibility of the Framework

The Basic Expeditionary Airfield Resources Program

In 2005 and 2006, PAF applied the framework outlined above to the BEAR program, which is a set of resources used to open and operate forward-deployed Air Force bases. It is an especially good candidate to demonstrate the PAF methodology because it is a substantial, mission-critical agile combat support program whose associated costs total nearly $100 million a year. BEAR incorporates hundreds of diverse items with different life-cycle characteristics and sustainment costs and practices. Moreover, it provides a unique capability that no other Air Force asset furnishes, thereby making the link between resources and capabilities more apparent.

The first step in the analysis was to define capability metrics in terms of national-level planning objectives. For this, the research team used a combination of steady-state and surge defense-planning scenarios. Next, the researchers used a PAF-developed tool called the Strategic Tool for the Analysis of Required Transportation (START) to translate a list of deployed aircraft and base conditions, including infrastructure support and threat level, into a list of resources needed to support mission objectives. One of START's major strengths is that, through automation, it can derive a list of resource requirements in minutes, in contrast to the

Cadets at the U.S. Air Force Academy in Colorado Springs, Colorado, learned to set up BEAR in a bare-base environment.

SrA Andy Karabelski steps out of a small shelter system after conducting a final inspection during an exercise at Holloman Air Force Base, New Mexico. Airman Karabelski is assigned to the 49th Materiel Maintenance Group.

lengthy time it would take functional area managers to do the same. PAF estimates of resource requirements for BEAR used categories of base types as a proxy for detailed base surveys. Equipment attrition rates, reconstitution costs, and time delays turned out to be the principal drivers of funding requirements.

One of the key findings of the BEAR case study was that planning for a worst-case scenario did not guarantee adequate preparedness for lesser cases. This reinforced the assertion that it is necessary to construct robust programs that are effective across a range of possible future scenarios. Furthermore, data have not been collected regularly on key elements of BEAR program results, attrition rates, and reconstitution costs. Ensuring that such analyses are not biased will require collecting and updating life-cycle data according to a standardized process so that results across time and locations are comparable.

The Air Force Vehicles and Equipment Programs

In 2007, the Air Force asked PAF to conduct a capabilities-based programming analysis of its vehicles and equipment programs. These programs are ripe targets for such analysis for several reasons. First, they are relatively large: $750 million per year for procurement—investment and operations and maintenance—and $30 billion in total replacement value. Second, although vehicles and equipment are not glamorous, they underpin everything the Air Force does, from launching training sorties to maintaining aircraft, providing security, maintaining bases, and moving cargo.

Finally, in contrast to the BEAR program, which has only a deployed mission and essentially no requirements for training, vehicles and equipment have substantial training requirements and thus have additional programming challenges that the BEAR study did not address.

PAF's analytical approach required developing operationally driven requirements for individual items. However, the sheer number of different types of vehicles and equipment—there are more than 100,000

One of START's major strengths is that, through automation, it can derive a list of resource requirements in minutes, in contrast to the lengthy time it would take functional area managers to do the same.

unique stock numbers and millions of individual assets, ranging in cost from a few dollars to millions—dictated constraining the scope to make the problem tractable. As a result, any asset or category of assets to be included in the analysis had the following three characteristics:

- The assets should be deployable because PAF's focus is on expeditionary capabilities, which is also the Air Force's main focus.
- The assets should support sortie generation as directly as possible.
- The set of assets to be deployed should constitute a significant portion of the budget.

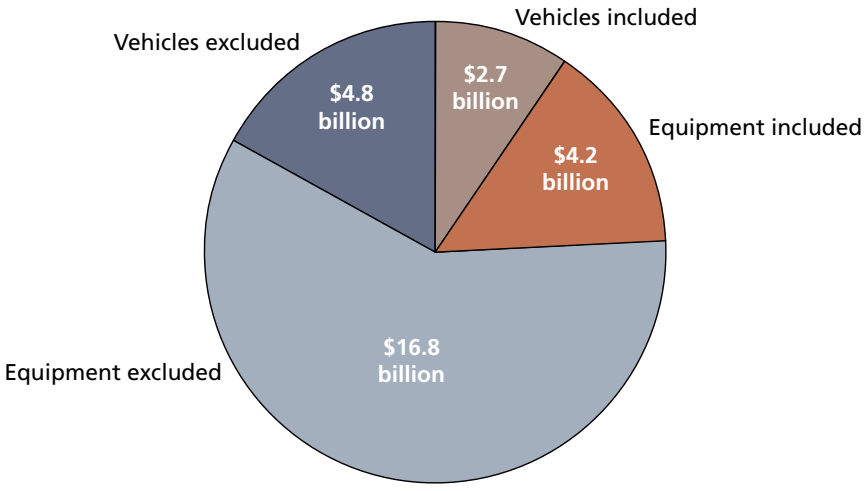
The analysis excluded general-purpose vehicles because the Air Force currently leases them during deployment.

As the figure shows, the PAF analysis encompassed about 25 percent of the total dollar value of the Air Force's entire inventory of vehicles and equipment, which exceeded $28 billion in fiscal year (FY) 2006. The items making up this sample constituted about one-third of all vehicles in the inventory, valued at $2.7 billion, and about one-fifth of all the equipment, valued at $4.2 billion.

In developing the original model and applying it to the BEAR program, the PAF research team considered only assets that were used in deployment. However, certain vehicles and equipment are used in both training and deployment activities. If the Air Force fully funds both activities, it expects to have adequate assets to carry them out. Given additional money, the Air Force could choose to supplement training and/or deployment activities in an effort to hedge against unforeseen circumstances.

On the other hand, because budgets are constrained, the Air Force has to choose where to accept risk. For example, if the Air Force chooses to accept risk for home-station capabilities, it can curtail training activities. If, instead, it accepts some level of risk in deployment, it might decide to reduce funding for war reserve materiel and either take the chance that one or more planned-for contingencies would not occur or risk degraded performance if one did.

Total Value of Air Force Vehicles and Equipment in FY 2006



SSgt Ryan Stark guides a 25K Halvorsen loader into position as A1C Tyler Johnson delivers cargo pallets to be loaded onto a C-17 Globemaster III that is headed for Afghanistan. PAF researchers identified potential resource imbalances within the Air Force's vehicle program, including excess inventory in one type of forklift. The Air Force has the option of retiring vehicles that exceed numerical requirements and using the money to purchase others that are needed to meet mission demands.

Using the START tool and data from OSD, PAF researchers estimated deployment requirements for capabilities specified in defense guidance and used Air Force planning factors to derive home-station requirements. The researchers then used automated assessment tools to calculate options and the consequences of various programming decisions according to the three algorithms described earlier: minimize cost in a single scenario set, maximize capability in a single scenario set, or develop a program that is robust across a range of scenario sets—i.e., one that maximizes capability over the entire portfolio.

A key question in any program is whether there are resource imbalances that should be remedied. According to PAF's analysis, the numbers of most firefighting and some lower-density aerial port vehicles, staircase trucks, and water trucks fell well below requirements. At the same time, several vehicles exceeded numerical requirements for less-stressing scenario sets, and one type of forklift exceeded all scenario requirements. PAF's calculations suggest that the Air Force could retire this excess inventory and use the money saved to purchase other vehicles needed to meet operational requirements.

PAF also assessed equipment levels against the same sets of requirements and looked for patterns in shortfalls and surpluses. Across both cost and category, researchers discerned no noticeable patterns, for example, at a certain cost level or within particular commodity types. However, most equipment within the scope of the study was aircraft related and generally well positioned to support sortie generation.

The PAF research team derived four primary conclusions from the analysis outlined above:

- Programming requirements depend greatly on the resource characteristics and scenarios included.
- Home-station requirements dominate program requirements for vehicles and equipment. The largest portion of the spending the optimization model generated was devoted to procurement, and the bulk of that was for reducing home-station deficits.

Patrick Mills

From the time he was a youngster growing up in Dallas, Texas, Patrick Mills had an inquisitive, analytical mind. "My favorite subjects in school were math and science," he says. "I had a rock collection, a stamp collection, an ant farm, a fish tank. I was always into something new." During high school, he developed an interest in physics, which he planned to pursue in college. The chair of the physics department at Texas Tech convinced him to add a second major, engineering.

However, halfway into his dual-degree program, he discovered industrial engineering, which he describes as a "this is where I really belong" moment. He switched his major and earned both a bachelor's and master's degree in that subject. According to Pat, "In most fields of engineering, the focus is on the design and use of a product—a machine, a bridge, a building. Industrial engineering centers on how efficiently and productively things are done. There the concern is with the assembly line, packaging, shipping, inventory levels, economics, optimizing the operations. It's mainly about systems."

Pat notes that, at this point in his life, he had no interest in research. He thought he'd be a "regular engineer" who designed systems and figured out how to do things better, most likely for a telecommunications company or a high-tech manufacturer. Then he met a senior operations researcher from RAND, who talked to him about the big national security policy problems that he and his colleagues worked on. Pat's reaction was, "Who are these people who advise decisionmakers? What a dream job!" And by 1999 he was a member of the RAND research staff.

So far, Pat's projects have primarily been in military logistics, where one of his key accomplishments has been to develop methodologies and tools that address strategic planning issues. The START model described in the accompanying research highlight is one such example. Capitalizing on his training as an industrial engineer, he has explored ways to evaluate the effects of support processes—e.g., maintenance, distribution, base support—on military operations.

Pat says that seeing his ideas gain some traction in various Air Force communities has been a very satisfying experience. "The relationship with the Air Force has been great. Our clients offer us exceptional access to the information we need and to the staff who work the problems we study. My colleagues and I are always trying to identify top-of-the-agenda issues, shape research questions that address those issues in a way that is useful to the client, and then come up with answers that can be applied in the real world."

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But for Pat the real world isn't just about work. Despite intense travel demands, he still finds time to serve as the lead elder in his church, where he chairs a board that provides oversight and helps create the internal structures necessary to serve a growing congregation. At the moment, he is also very busy helping his wife, Tanya, make the transition from math teacher to professional photographer. "This will allow her to express her creativity and give her more control over her time." That kind of flexibility will be especially important because they are now looking forward to their most important joint venture to date: building their family.

A P-19 fire truck sits ready to be loaded onto a C-130 Hercules bound for Mississippi for Hurricane Katrina relief efforts. A PAF research team found that the Air Force's inventory of most firefighting trucks and some lower-density aerial port vehicles, staircase trucks, and water trucks has fallen below the number needed to meet operational requirements.

- From a procurement perspective, the vehicle program appears well-enough funded to sustain the existing fleet through recapitalization and still have enough left over for new purchases.
- There are imbalances in the program that could be remedied straightforwardly.

Overarching Recommendation to the Air Force

PAF encourages the Air Force to address existing data challenges so that this kind of analysis can become routine. Specifically, reconstitution data for vehicles should be gathered in all regions to give the Air Force a more robust picture of postdeployment costs. For equipment, operations and maintenance and reconstitution data should likewise be systematically gathered and centrally recorded. These data already exist in some form in each local equipment maintenance shop. Currently, however, only equipment items with a purchase price of over $250,000 are tracked individually. While gathering accurate data can be burdensome, it is essential to the type of analysis described here. Therefore, data for the less expensive items must also be collected to routinize such analyses.

In today's budget environment, the Air Force must make increasingly difficult programming decisions. PAF's approach not only enables necessary trading among programs but also illuminates potential trades between deployed and home-station capabilities. PAF's methodology will also allow the Air Force to be more efficient by recommending programmatic decisions with balanced capabilities based on operational data. Air Force leaders already apportion capabilities and risks among these activities according to their own expert judgments. The PAF methodology will provide them more information with which to make such decisions.

FOR MORE INFORMATION, SEE

Assessing Capabilities and Risks in Air Force Programming: Framework, Metrics, and Methods, by Don Snyder, Patrick Mills, Adam C. Resnick, and Brent D. Fulton, MG-815-AF
http://www.rand.org/pubs/monographs/MG815/

Supporting Air and Space Expeditionary Forces: A Methodology for Determining Air Force Deployment Requirements, by Don Snyder and Patrick Mills, MG-176-AF
http://www.rand.org/pubs/monographs/MG176/

Restructuring the Combat Air Forces

An Assessment of Effects on Force Structure, Spending, and Manpower

F-16 Fighting Falcons, like the one shown here, flew close air support missions in Operation Iraqi Freedom. The Air National Guard also flies F-16s for air sovereignty alert missions in the United States. The Air Force will accelerate the retirement of 257 legacy fighter aircraft in FY 2010.

The Air Force must calibrate the size and capabilities of its forces to meet the diverse set of demands articulated in the National Defense Strategy. The fighter aircraft of the combat air forces (CAF) collectively contribute to meeting the demands of conventional conflicts; steady-state operations, including irregular warfare; and air sovereignty missions for homeland defense. The Air Force must keep the aging aircraft in its inventory viable until it can acquire sufficient new fifth-generation aircraft to meet the demands of challenging antiaccess and area-denial environments. Today's intense competition for defense funding creates a need for continuing assessments of the quantity and mix of forces required to meet national defense priorities.

In 2009, the Air Force proposed restructuring its CAF to reduce the number of aging fourth-generation fighter aircraft to free money and manpower for meeting critical needs. The plan for doing this has three main components:

- **Accelerate the retirement of 257 fourth-generation fighter aircraft in FY 2010.** Nine A-10s, 112 F-15C/Ds, and 136 F-16C/Ds would be retired from the total aircraft inventory. This would reduce the numbers of both combat and training aircraft by 13 percent. The Air Force expects to avoid spending $3.5 billion in operation and maintenance costs and another $0.1 billion in modification costs through FY 2015.
- **Reinvest the cost savings in high-priority force enhancements.** Among the priorities for additional investment are aircraft modifications, procurement of additional remotely piloted aircraft, and development of new missile and aircraft systems.
- **Reprogram approximately 4,000 manpower authorizations from the fighter force to other critical missions.** While the total Air Force population would not change, the shift in assignments would eventually augment Air Force capabilities to collect, process, exploit, and disseminate intelligence, surveillance, and reconnaissance information and to reinvigorate the nuclear enterprise.

The 2010 DoD Appropriations Act directed the Secretary of the Air Force to have a federally funded research and development center assess how the restructuring would affect the nation's CAF. The Air Force asked PAF to conduct the assessment, the results of which are summarized below.

Meeting Operational Demands and Sustaining Inventory Levels

PAF researchers analyzed the demands for CAF in a variety of near-term operational scenarios. They also used data on accumulated usage, recent utilization rates for each type of aircraft, and current Air Force estimates of economical service lives to project fighter inventories through FY 2030.

The restructured CAF would be close to the size needed to meet a variety of demands. The research showed that the retirement of 257 fourth-generation fighters will not appreciably increase existing operational risks in meeting these demands. However, it would be extremely difficult to

Shortfalls in the quantity of fifth-generation fighters and in LRS capabilities will complicate the Air Force's ability to meet the most challenging operational demands.

carry out a full spectrum of challenging operations simultaneously, with or without the restructuring. More importantly, in the near to medium term, shortfalls in the quantity of fifth-generation fighters and in LRS capabilities will complicate the Air Force's ability to meet the most challenging operational demands. Again, this assessment holds true with or without the restructuring.

The restructuring should have a minimal effect on the A-10 fleet. The reduction proposed for CAF's A-10 fleet would have a minimal effect because it reduces the total inventory by less than 3 percent and the number of combat-coded aircraft does not change. However, achieving the service-life goals for the remaining A-10s will require wing, fuselage, and engine modifications.

The Air Force's ability to sustain the planned F-15C/D force is uncertain. Significant uncertainty about the ultimate service life of the F-15C/D complicates inventory projections and force planning. The in-flight breakup of an F-15C in 2007 prompted a series of planned tests, inspections, and other initiatives that should reduce this uncertainty over the next several years. However, at the Air Force's current economic service-life planning estimate of 13,500 equivalent flight hours, the F-15C/D inventory could fall below the level needed to support the planned force by FY 2019. The Air Force could take a variety of steps to hedge against possible inventory shortfalls, including keeping some of the retired aircraft in inviolate storage until the actual service life is better understood.

The ability of the Air Force to sustain desired fighter force levels through FY 2030 depends on the success of the F-35 program and favorable service lives for aircraft currently in the inventory. The Air Force plans to replace F-16C/Ds and A-10s with new fifth-generation F-35 multirole aircraft. It should be able to sustain the fighter force levels expressed in the recent Quadrennial Defense Review through FY 2030 if

- the F-35 follows the schedule in the FY 2011 President's Budget and subsequently builds to a peak rate of 80 aircraft per year
- current aircraft achieve their projected economic service lives.

Neither of these outcomes is assured. The adequacy of fighter inventories would have to be reassessed if the service lives of current aircraft prove shorter than expected or if the F-35 program undergoes further schedule disruptions and/or if buy rates decrease because of cost growth or budgetary constraints. This assessment holds true with or without the restructuring.

The CAF restructuring has implications for overseas presence. The restructuring would reduce the Air Force fighter forces based in Europe by 14 percent, somewhat diminishing their capacity to train and otherwise engage with regional forces. It would also limit the Air Force's ability to deploy rapidly to trouble spots in Europe and the Middle East. Deploying forces based in the continental United States for exercises and periodic rotations through Europe could partially compensate for the decreased presence.

Crew chiefs perform maintenance on an F-15 Eagle during Red Flag exercises at Nellis Air Force Base, Nevada. The Air Force expects the CAF restructuring to save $3.6 billion in operations, maintenance, and modification costs through FY 2015.

The restructuring will have mixed effects on the air defense alert mission. The great majority of the squadrons assigned to such missions would not be affected, and most of those that were would receive better aircraft. However, the elimination of an F-15C/D squadron in Alaska and the replacement of F-15C/Ds with F-22s in Hawaii would mean that the Pacific Air Forces' comparatively small force of F-22s in these two locations would have to assume greater roles in air defense alert missions. F-22s would have to maintain ground alert and fly alert missions, making these aircraft less available for training in other critical fighter missions and consuming airframe life.

Cost Savings and Reinvestment

PAF analyzed recent spending on fighter forces to determine the amount of cost savings that could result from the restructuring. Researchers also compared budgets prepared before and after the restructuring was planned to determine whether the Air Force has invested in programs to enhance CAF capabilities.

Air Force estimates of cost avoidances appear plausible. The Air Force expects retiring aircraft for the restructuring to save $3.5 billion in operation and maintenance costs and $0.1 billion in modification costs between FYs 2010 and 2015. This estimate is consistent with recent spending on the fighter forces. If apparent trends of real growth in operation and maintenance costs continue, actual savings could be even greater than the initial estimates.

The Air Force has increased its spending on programs to enhance CAF capabilities. Tracing the reallocation of funds from one activity to another is virtually impossible. However, a comparison of budgets prepared before and after the restructuring was planned shows that the Air Force has already initiated or expanded programs to enhance CAF capabilities. For

example, the increased purchase of MQ-9 Reaper remotely piloted aircraft, the procurement of a wide-area sensor for that aircraft, and the procurement of new AC-130J gunships will address critical needs in ongoing contingency operations. Near-term modifications that allow B-52s to carry precision weapons, such as the Joint Air-to-Surface Standoff Missile and Joint Direct Attack Munition, internally and that add an active electronically scanned array radar and an infrared search and track system to the F-15C/D should enhance Air Force capabilities in major combat operations. Over the long term, programs to develop a new long-range strike capability and a new cruise missile could further enhance U.S. capabilities in such operations.

Ninety percent of these [manpower] authorizations will go to operating new intelligence, surveillance, and reconnaissance systems and to carrying out related processing, exploitation, and dissemination tasks.

Implications for Manpower

PAF examined Air Force plans to shift more than 4,000 manpower authorizations from the fighter force to other areas. These planned shifts address high-priority needs. The Air Force plans to apply 90 percent of these authorizations to operating new intelligence, surveillance, and reconnaissance systems and to carrying out related processing, exploitation, and dissemination tasks. The remainder will be used to improve the nuclear enterprise. Because the total number of personnel remains the same, no personnel costs will be saved. In the near term, the Air Force may incur some temporary transition costs due to the permanent change of station and training expenses associated with the shift in authorizations. Over the long term, the CAF restructuring may affect the Air Force's ability to fill staff positions that require rated pilots.

Conclusions

With or without the CAF restructuring, the Air Force faces an extended period of operational, acquisition, and sustainment risks. It will need more fifth-generation fighters, enhanced LRS capabilities, and critical munitions to counter the most challenging adversaries in the near to medium terms. The retirement of 257 fourth-generation aircraft does not significantly add to these risks. The reinvestment of funds and redistribution of people could prove particularly useful for ongoing irregular warfare operations, which are a top priority of the National Defense Strategy. Reinvestments will also improve the Air Force's ability to conduct major combat operations but will only partially compensate for the near-term lack of fifth-generation fighters and LRS capabilities.

Epilogue

PAF delivered its assessment to the Secretary of the Air Force at the end of March 2010. The Air Force subsequently forwarded the report to Congress and began to execute the CAF restructuring in April 2010.

William Stanley

When William Stanley came to RAND in 1972, he brought with him an advanced degree in engineering and work experience from the McDonnell Douglas Astronautics Company. But he acknowledges that, in those days, his education and training were far from complete. "At RAND, we try to think about all dimensions of a problem—not just the technical but also military, political, and economic aspects—and how they fit together. I learned how to do that through interactions with RAND staff from many other disciplines. Here, I can walk down the hall and talk to experts on something as specific as a cost-analysis method or as broad as China policy. You don't find that in many organizations. The RAND experience has also taught me how to hone a message, how to express complex technical subjects in a meaningful way to decisionmakers, and how a rigorous peer-review process can improve a research product. All of these things have enhanced my professional development and broadened the skills I can call upon to tackle diverse research topics."

Working with colleagues to develop a complete picture of the problem they're trying to solve is one of the characteristics of the RAND environment that, according to Bill, invigorates the research staff. "You're always looking at new questions or at old questions from a new direction. It keeps you from getting stale."

During his 38 years at RAND, Bill has had many opportunities to direct or participate in challenging research on a broad cross-section of military and civil topics that include airpower force employment; weapon system acquisition; aircraft accident investigation; and space, energy, transportation, and air pollution policies. In addition to studying how the CAF restructuring would affect the nation's ability to meet future national security demands, Bill has recently led projects on controlling collateral damage; aircraft weapon employment and survivability in recent major operations; the technical and policy implications of aging Air Force aircraft; and the feasibility of adapting smaller, lower-cost aircraft systems for counterinsurgency missions.

Bill's CAF research has been particularly gratifying because he and his colleagues were able to provide a timely, independent assessment of a policy action that could potentially free up billions of dollars within the Air Force's budget. "We wanted to provide a balanced assessment of risks and benefits and to do so in a matter of weeks," Bill said. "Experience from years of PAF force modernization and employment research and recent related work for the Air Combat Command allowed us to quickly respond to the Air Force's request for assistance."

Being able to apply research findings immediately to answer pressing questions is, of course, an analyst's dream. As Bill points out, "Having the right information at the right time and getting it to the right audience means that a RAND team can really make a contribution."

Although Bill is known for trying to avoid the spotlight, his outstanding record of achievement has not gone unnoticed. In 2008, he was selected as one of the first three recipients of the newly created PAF Research Excellence Award. Then, in 2010, he received RAND's highest research-related honor, the RAND President's Choice Award, in recognition of his work on the CAF restructuring and his decades-long contributions to Air Force policy analysis.

At RAND, we try to think about all dimensions of a problem—not just the technical but also military, political, and economic aspects—and how they fit together.

Project AIR FORCE Research Excellence Awards

In 2008, Project AIR FORCE (PAF) instituted an award to honor researchers who, year after year, have achieved the highest degree of excellence in their work. Winners receive support for professional development and a plaque recognizing their outstanding contributions. The selection committee includes the unit director, Andrew Hoehn; the associate director, Carl Rhodes; and the director of staff development, Michael Kennedy. PAF congratulates the 2010 Research Excellence Award winners, John C. Graser, Laura L. Miller, and Alan J. Vick, on their record of outstanding accomplishments.

John C. Graser

John C. Graser is being honored for his extensive work in cost analysis and acquisition issues for major weapon systems, most particularly his research contributions to several studies involving the F-22 Raptor aircraft. For one of these studies, he also received a RAND Merit Bonus Award this year. That project addressed a congressional requirement that the Air Force develop a plan regarding the disposition of tooling for the Raptor after production ends in 2012. Despite early indications that retaining the production tooling would not be cost-effective, Jack and his team determined that retention using a new storage concept was the most cost-effective option, especially since it had advantages unrelated to the resumption of production, which was considered unlikely to happen. The tooling could, for instance, be needed to repair battle damage or to extend the aircraft's service life by addressing unforeseen aircraft fatigue problems as part of the sustainment process. The team calculated that the cost of replacing the tooling ($194 million) was significantly higher than that of storing the tools ($17 million) as a hedge against such needs. Given this analysis, in June 2010 the Air Force notified Congress of its decision to preserve the production tooling.

Jack holds a BS in accounting from the University of Dayton, Ohio, and an MBA from the University of Utah.

Laura L. Miller

Laura L. Miller is being honored for her outstanding examination of civilian suicides and workforce wellness for the Air Force Materiel Command, as well as for her role in the recent study on the experiences and attitudes of active-duty Air Force spouses. Laura also lent her assistance this year to the Air Force study group that convened after the Ft. Hood shootings, which was headed by General Stephen Lorenz.

Laura's work focuses on the people of the Air Force—the leadership, the airmen, and their families—and the effects of various concerns on their welfare and readiness. Currently, she is coleading a project examining Air Force programs designed to increase the resiliency of airmen and their families in the face of the mounting stresses of deployments and other aspects of military service.

Laura holds a BA in European and Soviet studies from the University of Redlands and an MA and a PhD in sociology from Northwestern University.

Alan J. Vick

Alan J. Vick is being honored for his research for the U.S. Air Force on hardening and dispersal of bases in the western Pacific. Alan and his research teams have been exploring threats to U.S. Air Force bases for nearly two decades. His most recent work led the Air Force to think differently about its posture in the western Pacific. Increasingly accurate and lethal advanced missiles are making air bases more vulnerable and have proliferated to the point that they will significantly affect U.S. Air Force operations in the near term. Alan's groundbreaking work looked at a broad range of approaches, including new ways to deploy U.S. fighters, bombers, and tankers that would allow them to operate in the face of these enhanced threats.

As a mentor to new researchers and junior staff, Alan has been gracious with his time and talents over the years, offering important and challenging problems that play to the researchers' strengths, providing guidance, and pushing them to excel.

He is an alumnus of the University of California, Irvine, holding a BA and PhD in political science and an MA in social science.

Recent Publications

Strategy and Doctrine

Courses of Action for Enhancing U.S. Air Force "Irregular Warfare" Capabilities: A Functional Solutions Analysis, by Richard Mesic, David E. Thaler, David Ochmanek, and Leon Goodson, MG-913-AF.
http://www.rand.org/pubs/monographs/MG913/

Deterrence and First-Strike Stability in Space: A Preliminary Assessment, by Forrest E. Morgan, MG-916-AF.
http://www.rand.org/pubs/monographs/MG916/

Developing an Assessment Framework for U.S. Air Force Building Partnerships Programs, by Jennifer D. P. Moroney, Joe Hogler, Jefferson P. Marquis, Christopher Paul, John E. Peters, and Beth Grill, MG-868-AF.
http://www.rand.org/pubs/monographs/MG868/

The Iraq Effect: The Middle East After the Iraq War, by Frederic Wehrey, Dalia Dassa Kaye, Jessica Watkins, Jeffrey Martini, and Robert A. Guffey, MG-892-AF.
http://www.rand.org/pubs/monographs/MG892/

Pakistan: Can the United States Secure an Insecure State? by C. Christine Fair, Keith Crane, Christopher S. Chivvis, Samir Puri, and Michael Spirtas, MG-910-AF.
http://www.rand.org/pubs/monographs/MG910/

Recasting NATO's Strategic Concept: Possible Directions for the United States, by Christopher S. Chivvis, OP-280-AF.
http://www.rand.org/pubs/occasional_papers/OP280/

Troubled Partnership: U.S.-Turkish Relations in an Era of Global Geopolitical Change, by F. Stephen Larrabee, MG-899-AF.
http://www.rand.org/pubs/monographs/MG899/

Manpower, Personnel, and Training

The Acquisition Cost-Estimating Workforce: Census and Characteristics, by Georges Vernez and Hugh G. Massey, TR-708-AF.
http://www.rand.org/pubs/technical_reports/TR708/

The Air Force Officer Qualifying Test: Validity, Fairness, and Bias, by Chaitra M. Hardison, Carra S. Sims, and Eunice C. Wong, TR-744-AF.
http://www.rand.org/pubs/technical_reports/TR744/

Air Force Officer Specialty Structure: Reviewing the Fundamentals, by Raymond E. Conley and Albert A. Robbert, TR-637-AF.
http://www.rand.org/pubs/technical_reports/TR637/

An Analysis of the Populations of the Air Force's Medical and Professional Officer Corps, by Edward G. Keating, Hugh G. Massey, Judith D. Mele, and Benjamin F. Mundell, TR-782-AF.
http://www.rand.org/pubs/technical_reports/TR782/

Cultural Themes in Messages from Top Air Force Leaders, 2005–2008, by Carolyn Chu, Brandon Dues, and Laura L. Miller, DB-583-AF.
http://www.rand.org/pubs/documented_briefings/DB583/

Human Capital Management for the USAF Cyber Force, by Lynn M. Scott, Raymond E. Conley, Richard Mesic, Edward O'Connell, and Darren D. Medlin, DB-579-AF.
http://www.rand.org/pubs/documented_briefings/DB579/

Year of the Air Force Family: 2009 Survey of Active-Duty Spouses, by Laura L. Miller, Sarah O. Meadows, Lawrence M. Hanser, and Stephanie L. Taylor, TR-879-AF, forthcoming.

Resource Management

Best Practices in Developing Proactive Supply Strategies for Air Force Low-Demand Service Parts, by Mary E. Chenoweth, Jeremy Arkes, and Nancy Y. Moore, MG-858-AF. http://www.rand.org/pubs/monographs/MG858/

Ending F-22A Production: Costs and Industrial Base Implications of Alternative Options, by Obaid Younossi, Kevin Brancato, John C. Graser, Thomas Light, Rena Rudavsky, and Jerry M. Sollinger, MG-797-AF. http://www.rand.org/pubs/monographs/MG797/

Global Combat Support Basing: Robust Prepositioning Strategies for Air Force War Reserve Materiel, by Ronald G. McGarvey, Robert S. Tripp, Rachel Rue, Thomas Lang, Jerry M. Sollinger, Whitney A. Conner, and Louis Luangkesorn, MG-902-AF. http://www.rand.org/pubs/monographs/MG902/

A Repair Network Concept for Air Force Maintenance: Conclusions from Analysis of C-130, F-16, and KC-135 Fleets, by Robert S. Tripp, Ronald G. McGarvey, Ben D. Van Roo, James M. Masters, and Jerry M. Sollinger, MG-919-AF. http://www.rand.org/pubs/monographs/MG919/

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