For more than 70 years, the RAND Corporation has worked side by side with government as a trusted adviser. Through high-quality, objective research and the development of sophisticated analytic tools, RAND researchers from diverse disciplines and perspectives collaborate to create strategies and solutions to keep our nation strong.
The COVID-19 pandemic has tested the resilience and adaptiveness of every individual, organization, institution, and nation. The RAND Corporation is no exception, and we have been challenged to draw on our operational adaptability in ways we could not have anticipated. Beginning in March 2020, RAND shifted to physically distanced and remote operations, avoiding a major business disruption. As a result, RAND Arroyo Center has continued to meet its commitments to the Army, delivering analyses and tools without avoidable delays or compromises in quality.

At the same time, Arroyo concentrated on one aspect of its mission, to provide the Army with short-term assistance on urgent problems. As the pandemic unfolded, Arroyo provided Army leaders with expert consultation and quick-turn analyses to address their emerging questions about the implications of COVID-19.

Many questions concerned the Army's own operations:
- How might the pandemic affect the Army’s people and its installations?
- How might COVID-19 affect readiness?
- What might be the effects on recruiting, training, equipping, mobilizing, and other functions?

Other questions concerned the international environment:
- How might COVID-19 affect U.S. partners and allies?
- How might potential adversaries, both states and violent nonstate actors, seek to exploit the pandemic to their advantage?
- How might the pandemic affect the demand for ground forces?

Arroyo was able to answer such wide-ranging questions because of the broad expertise resident in RAND’s multidisciplinary research staff, which includes not only defense analysts but also epidemiologists, economists, and other experts who conduct research related to the challenges posed by COVID-19.

This RAND Arroyo Center Annual Report, covering fiscal year 2020, focuses on Arroyo’s published analyses, the output of Arroyo’s mission to conduct objective analytic research on major policy concerns, with an emphasis on mid- to long-term policy issues. It is organized into several short sections that emphasize different dimensions of the support that Arroyo provides the Army as its sole federally funded research and development center (FFRDC) for studies and analysis.
The first section highlights Arroyo’s sustained focus on the Army’s perennial challenges and high priorities. It highlights multiyear streams of research in seven areas: Russia; China and the Indo-Pacific; working with allies and partners; soldiers and families; military health care; business reform; and tools (models, methodologies, and wargames).

The second section summarizes nine outstanding analyses that address each of the Army’s highest priorities: readiness (e.g., “How Should the Army Use Simulators to Conduct Collective Training”), modernization (“Army Fires Capabilities for 2025 and Beyond”), reform (“How Army Commands Can Improve Accounting, Transparency, and Auditability”), and people (“Helping Army Spouses Address Life’s Challenges”). These summaries showcase the high quality of individual analyses, as well as the diversity of disciplines and methodologies that Arroyo brings to bear on the Army’s problems.

The third section describes the oversight and management arrangements that help Arroyo stay on point analytically and deliver a high return on the Army’s investment in its FFRDC. A close, deeply collaborative relationship with the Army is key to Arroyo’s success. It enables Arroyo researchers to build familiarity with Army systems, people, and data and to stay responsive to changing priorities and conditions. The Army also entrusts Arroyo with the independence needed to conduct high-quality, objective analyses that have credibility with the larger defense community and with Congress.

The report closes with an infographic that displays the range and volume of Arroyo’s analytic effort, as indicated by recent research publications.

I encourage you to share this Annual Report with anyone who would be interested in its contents and messages. Please contact me at any time if you wish to receive more information regarding any aspect of RAND Arroyo Center or its research activities.

With best wishes,

Sally Sleeper
Director, RAND Arroyo Center
703-413-1100 x5213
The following pages highlight topics of critical importance to Army leadership in which RAND Arroyo Center has sustained streams of research and analyses.

• Russia
• China and the Indo-Pacific
• Working with Allies and Partners
• Soldiers and Families
• Military Health Care
• Business Reform
• Tools
Russia

U.S. competition with Russia in Europe is likely to remain below the threshold of armed conflict, but Russian activities in this “gray zone” can still compromise U.S. and NATO interests. The United States can counter and deter Russia by enhancing force posture in the region, conducting exercises with allies and partners, and exploiting operations in the information environment. Modernization of military capabilities and technology can also strengthen the U.S. position in competition but runs the risk of escalation. Each year, Arroyo devotes a substantial stream of research to understanding the implications of the Russian threat for Army modernization, planning, and investment decisions.

Understanding the Deterrent Impact of U.S. Overseas Forces
www.rand.org/t/RR2533

This report provides empirical evidence on the deterrent effects of U.S. overseas military forces. It also offers guidance about how the deterrent effects of forces may vary by their type, size, and location.

What Provokes Putin’s Russia? Deterring Without Unintended Escalation
www.rand.org/t/PE338

What provokes Putin’s Russia, especially in the context of NATO’s current deterrence efforts? The authors identify Russia’s redlines and analyze current U.S. and NATO deterrence efforts.

Competing in the Gray Zone: Russian Tactics and Western Responses
www.rand.org/t/RR2791

The authors summarize a series of war games played to better understand European vulnerabilities to Russian gray-zone tactics—ambiguous actions that target domestic or international public opinion—and how to effectively counter them.

Understanding Russian Subversion: Patterns, Threats, and Responses
www.rand.org/t/PE331

The authors examine the interests that inspire Russia’s use of subversion, the means involved, recent events that illustrate attempts at Russian subversion, and ways to improve the response to subversion attempts.

Russia’s Limit of Advance: Analysis of Russian Ground Force Deployment Capabilities and Limitations
www.rand.org/t/RR2563

Analysis of Russian military capabilities reveals stark limitations in Russia’s ability to safely and effectively deploy and sustain ground forces around the world.

Trends in Russia’s Armed Forces: An Overview of Budgets and Capabilities
www.rand.org/t/RR2573

The authors analyze recent and current trends in the Russian military, including its budget; assess strengths and weaknesses of its land, air, and naval forces; and consider how its capabilities are being integrated in practice.

Russia’s Use of Media and Information Operations in Turkey: Implications for the United States
www.rand.org/t/PE278

The author assesses how Russia has used media and information operations to support its foreign policy goals related to Turkey.
China has emerged as a near-peer competitor of the United States, both economically and militarily, and is taking an increasingly aggressive position in the Indo-Pacific region. To deter and compete with China successfully, the United States needs to develop innovative concepts for force posture and employment, advanced technologies, and an agile force structure while also strengthening its relationships with regional allies and partners to ensure access and opportunities for forward positioning. Arroyo analyses are helping the Army define the critical contributions of land forces to these efforts.

To explore what extended competition between the United States and China might entail out to 2050, the authors of this report assess how successful China might be at implementing its grand-strategy goals over the next three decades.

A series of visualizations brings into sharp relief the threat posed by the massive numbers of North Korean conventional artillery systems that are within range of major South Korean population centers.

The authors assess the strategic competition among Russia, China, and the United States for global influence.

To hedge against a collapse of the Intermediate-Range Nuclear Forces Treaty, the Army should assess the potential benefits and risks of adding conventional land-based theater ballistic missiles to the U.S. arsenal.

Mounting costs, risks, and public misgivings of waging war are raising the importance of U.S. power to coerce (P2C). The best P2C options are financial sanctions, support for political opposition to hostile regimes, and offensive cyber operations.

The Army and the Air Force are developing the concept of Multi-Domain Battle to better coordinate air and ground forces to meet shared challenges.

To assist the Army in its reorientation toward conventional combat operations, the authors identify capability gaps in the field artillery. They also recommend actions that the Army should consider taking from today to roughly 2030.
Allies and partners are critical to U.S. efforts to achieve strategic goals, deter aggression, and, when deterrence fails, prosecute coordinated military action to defeat adversaries. But pursuing U.S. interests by working with and through allies and partners presents complex challenges of interoperability. These challenges are not only technological but also strategic, operational, and tactical. Recent Arroyo analyses conducted to help the Army overcome these interoperability challenges include the following.

### DDR in Afghanistan: Disarming, Demobilizing, and Reintegrating Afghan Combatants in Accordance with a Peace Agreement
[www.rand.org/t/PE343](http://www.rand.org/t/PE343)

The authors identify best practices in the disarmament, demobilization, and reintegration field in the context of conditions in Afghanistan and recommend steps that the Army and government can take to advise and assist the Afghan government.

### Turkey’s Nationalist Course: Implications for the U.S.-Turkish Strategic Partnership and the U.S. Army
[www.rand.org/t/RR2589](http://www.rand.org/t/RR2589)

The long-standing U.S. strategic partnership with Turkey, a powerful NATO ally, has become strained in recent years. Arroyo researchers assess challenges confronting the partnership and advance recommendations for sustaining it over the coming decade.

### Seizing the Golden Hour: Tasks, Organization, and Capabilities Required for the Earliest Phase of Stability Operations
[www.rand.org/t/RR2633](http://www.rand.org/t/RR2633)

This report analyzes the golden hour—the early phase of a postconflict stability operation—and the actions, organization, and capabilities necessary to seize it and set the conflict-affected country on a path to self-sustaining peace.

### Chasing Multinational Interoperability: Benefits, Objectives, and Strategies
[www.rand.org/t/RR3068](http://www.rand.org/t/RR3068)

National defense policies have focused on the importance of multinational interoperability to meeting U.S. defense goals. By recounting both their literature review and interviews, the authors describe the potential benefits of interoperability.

### Lessons from Others for Future U.S. Army Operations in and Through the Information Environment
[www.rand.org/t/RR1925z1](http://www.rand.org/t/RR1925z1)

This examination of the evolution of both allied and adversary use of information power, alongside a comparative analysis of capability areas in which these others excel, can guide future Army force planning.

### U.S. Strategic Interests in the Middle East and Implications for the Army
[www.rand.org/t/PE265](http://www.rand.org/t/PE265)

The authors examine threats to U.S. interests in the Middle East and factors associated with success and failure in U.S. military interventions and offer recommendations for the Army as it prepares for future involvement in the region.

### Smarter Power, Stronger Partners, Volume I: Exploiting U.S. Advantages to Prevent Aggression
[www.rand.org/t/RR1359](http://www.rand.org/t/RR1359)

The authors examine trends in military capabilities among potential U.S. adversaries and propose an alternative way for the United States to secure its interests.
Soldiers and Families

GEN McConville identifies people as the Army’s number-one priority, emphasizing that this includes not only soldiers but also their family members and Army civilians, retirees, and veterans. The Army’s commitment to its people encompasses their health, well-being, financial security, and quality of life. RAND is uniquely positioned to conduct analyses supporting this priority because RAND’s research areas include not only national security but also children, families, and communities; education and employment; and health and aging. Recent Army-sponsored analyses have focused on the Army’s people from recruitment through retirement.

**Today’s Army Spouse Survey: How Army Families Address Life’s Challenges**

[www.rand.org/t/RR3224](www.rand.org/t/RR3224)

This report identifies challenges that Army families face and resources they need, from the perspectives of spouses, including how spouses prioritize needs and how the Army can best address their most-pressing unmet needs.

**Setting Military Compensation to Support Recruitment, Retention, and Performance**

[www.rand.org/t/RR3197](www.rand.org/t/RR3197)

Drawing on a large body of research, this RAND Arroyo Center report describes military compensation as a strategic human resource tool. The author also reviews how well compensation works in this capacity and how it could be improved.

**Effects of the Blended Retirement System on United States Army Reserve Participation and Cost**

[www.rand.org/t/RR2591](www.rand.org/t/RR2591)

Analysis of the new Blended Retirement System (BRS) finds that it can sustain U.S. Army Reserve participation relative to the legacy system. The analysis also predicts continuation-pay cost and the percentage of reservists opting in to the BRS.

**Resources Required to Meet the U.S. Army’s Enlisted Recruiting Requirements Under Alternative Recruiting Goals, Conditions, and Eligibility Policies**

[https://www.rand.org/t/RR2364](https://www.rand.org/t/RR2364)

This project sought to enhance efficient use of Army recruiting resources and policies by optimizing required resource levels and mix to support recruiting under varying requirements, environments, and eligibility policies.

**Life as a Private: A Study of the Motivations and Experiences of Junior Enlisted Personnel in the U.S. Army**

[www.rand.org/t/RR2252](www.rand.org/t/RR2252)

Who joins the Army, why, and how satisfied are they with their decisions? This study’s portrayal of Army privates could serve as an educational tool for Army senior leadership, junior officers, noncommissioned officers, and prospective recruits.

**Today’s Soldier: Assessing the Needs of Soldiers and Their Families**

[www.rand.org/t/RR1893](www.rand.org/t/RR1893)

This report describes results of a survey of 7,000 soldiers about the problems that they and their families face, their needs for assistance, their use of Army and non-Army resources to address those needs, and the implications of unmet needs for soldiers.

**Searching for Information Online: Using Big Data to Identify the Concerns of Potential Army Recruits**

[www.rand.org/t/RR1197](www.rand.org/t/RR1197)

This report assesses empirical applications of web search data and discusses the prospective value such data can offer Army recruiting efforts.
Military Health Care

Individual and unit readiness depend fundamentally on the physical and behavioral health of soldiers, both at home station and while deployed. The Army regularly sponsors health-related analyses that draw on RAND’s broad expertise in the access, quality, and affordability of medical care, as well as in health challenges, such as posttraumatic stress disorder, substance misuse, sexual assault, suicidality, and the COVID-19 pandemic. Recent examples of Arroyo analyses conducted in support of military health care include the following.

Improving Behavioral Health Care for U.S. Army Personnel: Identifying Predictors of Treatment Outcomes
www.rand.org/t/RR2829
This report identifies factors associated with changes in outcomes for soldiers who received Army behavioral health specialty care and provides recommendations to improve care and outcomes for posttraumatic stress disorder, depression, and anxiety.

Comparing the Army’s Suicide Rate to the General U.S. Population: Identifying Suitable Characteristics, Data Sources, and Analytic Approaches
www.rand.org/t/RR3025
Researchers investigate how accounting for demographic factors beyond age and gender (race/ethnicity, time, marital status, and educational attainment) affects suicide rate differences between soldiers and the general U.S. population.

Options for Maintaining Clinical Proficiency During Peacetime
www.rand.org/t/RR2543
The U.S. Army Medical Department cares for the war wounded during conflict and operates medical treatment facilities that care for service members, their beneficiaries, and military retirees. How can the Army help providers prepare at home for wartime?

The Neurological Effects of Repeated Exposure to Military Occupational Blast: Implications for Prevention and Health; Proceedings, Findings, and Expert Recommendations from the Seventh Annual Department of Defense State-of-the-Science Meeting
www.rand.org/t/CF380z1
The 2018 Department of Defense State-of-the-Science Meeting examined the risk posed to military personnel by low-level blast exposure, the current evidence base, and potentially promising approaches to prevent and detect blast injuries.

www.rand.org/t/RR1006
The Army is developing a system to inform leaders of individual- and unit-level suicide risk factors and to support prevention and intervention activities. RAND convened an expert panel to identify necessary data and recommend leader actions.

Enhancing Military–Civilian Medical Synergies: The Role of Army Medical Practice in Civilian Facilities
www.rand.org/t/RR1313
In this report, researchers assess Army medical practice in U.S. Department of Veterans Affairs and non–Veterans Affairs civilian facilities and suggested opportunities for improving military-civilian synergies.

Optimizing Army Medical Materiel Strategy
www.rand.org/t/RR2646
This report describes how the Army can optimize its medical materiel strategies for efficient medical equipping readiness.
Business Reform

U.S. Army business processes must be efficient to maximize resources available for conducting current operations and modernizing warfighting capabilities. Business reforms are particularly important to continually improve management of the Army’s vast and complex investments in military equipment, supplies, and facilities. Arroyo has maintained decades-long research streams devoted to improving Army policies and practices in supply chain and inventory management, financial management, and installation management. Recent analyses in these areas include the following.

Assessment of Alternative Funding Models for Activities in RDECOM (Now CCDC) and ATEC
www.rand.org/t/RR2818
Current funding models and impacts of alternative models are assessed by the authors to help the Army increase the transparency of reimbursable accounting practices and improve auditability at two Army commands.

Improving Army Installation Facility and Land Use Deals and Partnerships
www.rand.org/t/RR2696
This report assesses Army installation real estate and facility-sharing deals and partnership approaches, such as large-scale leasing, and provides recommendations to improve installation use of these approaches to increase benefits and save costs.

Improving the Allocation and Execution of Army Facility Sustainment Funding
www.rand.org/t/RR3240
To identify strategies and make recommendations to improve the allocation and execution of Army installation facility sustainment funding, the authors compare Army practices with those in the other services and in the public and private sectors.

Army Installation Rail Operations: Implications of Increased Outsourcing
www.rand.org/t/RR2009
The authors evaluate the three business models that the Army relies on for its on-post rail operations and determine whether greater reliance on commercial rail assets could meet Army rail needs at a lower cost.

Alternatives for Reducing Army Installation Utility Bills While Enhancing Installation Readiness
www.rand.org/t/RR2773-1
Researchers identified options for reducing installation utility costs in three areas: reducing commodity payments, finding alternative funding sources for energy and water system investments, and leveraging nontraditional partnerships.

Military Installation Public-to-Public Partnerships: Lessons from Past and Current Experiences
www.rand.org/t/RR1419
This report explores the value in defense installations working with municipalities and other government organizations to create public-to-public partnerships. It also identifies and suggests ways to overcome barriers to cost-effective application.

Measuring and Managing Army Supply Chain Risk: A Quantitative Approach by Item Number and Commercial Entity Code
www.rand.org/t/RR902
This report provides background on supply chain risk management, strategic sourcing, and management of the supplier relationship. The authors present a methodology to estimate Army supply chain risk and identify factors that increase risk.

Water Management, Partnerships, Rights, and Market Trends: An Overview for Army Installation Managers
www.rand.org/t/RR933
This report assesses water management, partnerships, rights, and market trends and opportunities, as well as how Army installations can potentially improve programs and investments in water and wastewater systems.
tools

Arroyo regularly develops new analytic tools to support U.S. Army activities in policy development, implementation, and assessment. Some tools are designed to elicit insights and facilitate understanding of complex information; these include wargames, interactive databases, and data visualizations. Other tools, such as models and methodologies, are designed to support Army planning and policymaking. Arroyo also extends the capabilities of existing Army tools. Recent examples of Arroyo tool development include the following.

**Tools**

**A History of U.S. Military Policy from the Constitution to the Present: A Path to Army Total Force Policy**
www.rand.org/t/TL238

The authors show that there is no such thing as a traditional U.S. military policy. Rather, the laws that authorize, empower, and govern the U.S. armed forces emerged from long-standing debates and legislative compromises between 1903 and 1940.

**Assessing Force Sufficiency and Risk Using RAND’s Multi-Period Assessment of Force Flow (MPAFF) Tool**
www.rand.org/t/RR1954

This report describes RAND’s Multi-Purpose Assessment of Force Flow tool for conducting time-phased analysis of Army force sufficiency under a variety of assumptions about force generation policies, readiness policies, and force employment policies.

**New Metrics and Visualizations to Help the Army Reduce Customer Wait Time**
www.rand.org/t/RR2778

To help Army managers manage customer wait time, the authors developed several metrics and visualizations, including the rifle chart and a count of old orders, that use data available in the Army’s logistics enterprise system.

**Gaming Gray Zone Tactics: Design Considerations for a Structured Strategic Game**
www.rand.org/t/RR2915

The authors developed a strategic-level structured card game examining a gray zone competition between Russia and the West in the Balkans to better understand the nature of a gray zone competition with Russia.

**Developing a National Recruiting Difficulty Index**
www.rand.org/t/RR2637

The Army recognizes that the recruiting environment has a significant impact on its ability to recruit. This report presents a forecasting model that measures recruiting difficulty to forecast a difficult or easy recruiting environment.

**Prospective Outcome Assessment for Alternative Recruit Selection Policies**
www.rand.org/t/RR2267

To help the Army select recruits more likely to complete their first terms and avoid adverse outcomes, this report describes a tool that estimates how changes in a variety of recruit characteristics affect first-term outcomes and costs to the Army.

**Strategic Planning Tools for the Army Senior Reserve Officers’ Training Corps Program**
www.rand.org/t/RR1501

The Army must monitor Reserve Officers’ Training Corps (ROTC) units to ensure that it attracts and commissions highly qualified officers. Two new strategic planning tools can help the Army evaluate and choose ROTC hosts and affiliates.

**Interfacing Force-on-Force and Communications Models: MANA and JNE**
www.rand.org/t/TL201

This report documents an interface between an agent-based force-on-force simulation and a network simulation for the Army’s Cyber Center of Excellence, Capabilities Development and Integration Directorate, Cyber Battle Lab.
The following pages present summaries of recently published RAND Arroyo Center analyses that represent the quality and breadth of the research conducted for the Army.

• Russia’s Future Ground Combat Capabilities
• Measuring the Effectiveness of Special Operations
• The Deterrent Impact of U.S. Overseas Forces
• How Should the Army Use Simulators to Conduct Collective Training?
• Helping Army Spouses Address Life’s Challenges
• Enabling the Army to Predict When Recruiting Will Become Difficult
• How Army Commands Can Improve Accounting Transparency and Auditability
• Automating Army Supply Convoys
• Army Fires Capabilities for 2025 and Beyond
Understanding how Russian military capabilities will develop over the next 20 years (through 2040) is critical to future Western defense planning. To contribute to this understanding, RAND Arroyo Center analyzed the factors that influence the development of Russian military power, projected the development of key ground combat capabilities, and identified the challenges for the U.S. Army.

Factors Influencing Russian Military Power

Russia's military power is influenced by strategic, economic, demographic, and societal factors that are likely to remain relatively stable through 2030:

- Russia's defense strategy will remain focused on five missions: strategic deterrence to prevent aggression on the Russian homeland, regional dominance in the "near abroad" (i.e., the non-Baltic former Soviet Union), expeditionary operations, preparedness in case of a major ground war, and domestic stability.
- Russia is projected to experience relatively stagnant economic growth.
- Russia's population will likely support a mixed conscript and contract manning system for the military.
- Public attitudes consistently show support for Russia's government, foreign policies, and military.

The stability of these factors should enable Russia to continue to incrementally modernize its military power.

Key Capability Areas for Ground Combat

To project Russia's future ground combat capabilities, the research team analyzed developments in eight key capabilities (see table). The overall outlook in these capabilities is continuity, but there is substantial variation by capability, with different implications for the U.S. Army:

- **Maneuver ground forces**: Russia will continue to upgrade its legacy maneuver ground forces. Modernized Soviet-era platforms, such as the T-72B3, can be made almost as effective as new platforms with the addition of new components. For this reason, Russia will proceed slowly with investments in the next generation of platforms.
- **Indirect fire (<100 kilometer range)**: Russia has maintained a formidable indirect fire threat by retaining a large volume of Soviet-era launchers and munitions without significant modernization. Russia will continue to upgrade these legacy systems for indirect fire and proceed very slowly in the development of the next-generation platforms.

**Key Points**

- Russia is likely to expand and incrementally improve some ground combat capabilities, including long-range strike; rapidly deployable forces; command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR); and air defense.
- Maneuver ground forces and indirect fire capabilities will remain relatively stagnant.
- Russia would likely reprioritize the development of specific capabilities in response to changes in strategic or economic factors, such as economic decline or shifting relations with the West or China.
- The United States should endeavor to respond to the continuous evolution of Russian ground combat capabilities without provoking escalation in their development.

Russia’s Future Ground Combat Capabilities

Understanding how Russian military capabilities will develop over the next 20 years (through 2040) is critical to future Western defense planning. To contribute to this understanding, RAND Arroyo Center analyzed the factors that influence the development of Russian military power, projected the development of key ground combat capabilities, and identified the challenges for the U.S. Army.
### The continuing development of Russian ground combat capabilities has implications for the U.S. Army

<table>
<thead>
<tr>
<th>Capability</th>
<th>Expectations for Russian developments</th>
<th>Implications for the U.S. Army</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maneuver ground forces</td>
<td>Legacy platforms with new components; slow adoption of next-generation systems</td>
<td>Prepare to be challenged more by the large size of the Russian force than by next-generation platforms</td>
</tr>
<tr>
<td>Indirect fire</td>
<td>Continued Soviet-era capabilities</td>
<td>Consider how to counter C4ISR, attrit long-range indirect fire, and pursue dispersal, denial, and deception</td>
</tr>
<tr>
<td>Long-range strike</td>
<td>Increase in capacity and capabilities</td>
<td>Prepare for attacks on rear echelon in case of major conflict</td>
</tr>
<tr>
<td>Rapidly deployable forces</td>
<td>Steady investment and gradual improvement</td>
<td>Expect to see Russian forces or proxies in Europe, the Middle East, and other locations</td>
</tr>
<tr>
<td>C4ISR</td>
<td>Related achievement of modernized networks; new ISR platforms</td>
<td>Improve U.S. cyber and electronic warfare at the tactical and operational levels</td>
</tr>
<tr>
<td>Air defense</td>
<td>Slow improvement that threatens U.S. air superiority</td>
<td>Develop capabilities to counter antiaccess/area denial</td>
</tr>
<tr>
<td>Electronic warfare</td>
<td>Continued improvement</td>
<td>Explore options to protect positioning, navigation, and timing and ISR</td>
</tr>
<tr>
<td>Internal security forces</td>
<td>Maintenance of current size, unless extreme domestic events occur</td>
<td>Expect consistent resources for military even if Russia experiences internal unrest</td>
</tr>
</tbody>
</table>

NOTE: C4ISR = command, control, communications, computers, intelligence, surveillance, and reconnaissance; ISR = intelligence, surveillance, and reconnaissance.

- **Long-range strike (>100 kilometer range):** Russia has retained and adapted Soviet designs of long-range strike systems while emulating and adapting U.S. operating concepts in its doctrine and approach. Production of cruise and ballistic missiles will continue.

- **Rapidly deployable forces:** Russia’s rapidly deployed forces—including the airborne and special operations forces (Spetsnaz)—are built on Soviet-era formations, but they represent new and better-equipped forces. Russia will continue investment in rapidly deployable forces, and their effectiveness will improve with the introduction of new technology.

- **C4ISR:** Russia’s C4ISR capability combines legacy Soviet systems with employment concepts, such as net-centric warfare. Russia is pursuing advanced C4ISR systems, including unmanned aerial vehicles (UAVs), and will make progress in closing the capability gap with the West.

- **Air defense:** Russia’s highly advanced air defense systems build on the extensive Soviet-era investment in air defenses. Russia will continue to be a leader in air defense.

- **Electronic warfare:** Russia has invested in electronic warfare capabilities to counter asymmetrically perceived U.S. advantages. Russia will continue to seek electronic warfare systems.

- **Internal security forces:** Russia has built its internal security forces from pieces of Soviet-era structures within newly created or reorganized institutions. These forces will continue to receive funding and political support.

Although continuity is the most likely outlook for Russian ground combat capabilities, the factors that influence the development of military power could possibly change substantially. For example, Russia would be likely to reprioritize specific military capabilities if its strategic relationship with the West or with China shifted substantially.

### Implications for the U.S. Military

Russia’s development of its ground combat capabilities reflects its defense strategy, within the constraints of its economic performance, defense budget, demographics, and military personnel system. Russia’s focus on strategic deterrence and regional dominance, for example, points to Russia’s prioritization of long-range conventional strike, C4ISR, and air defense, while its focus on regional dominance has led to the prioritization of rapidly deployable forces.

To achieve U.S. interests, the U.S. military will need to provide forces that can compete with these capabilities in different regions and contexts, including NATO member states, former Soviet republics (such as Ukraine), and the Middle East. The analysis of capability gaps, detailed in the table, can provide insight as the U.S. Army considers options for developing its own capabilities. A key challenge will be how to develop U.S. capabilities without provoking Russia to escalate the development of improved or expanded military capabilities.

This summary is based on Andrew Radin, Lynn E. Davis, Edward Geist, Eugenius Han, Dara Massicot, Matthew Povlock, Clint Reach, Scott Boston, Samuel Chirap, William Mackenzie, Katya Migacheva, Trevor Johnston, and Austin Long, The Future of the Russian Military: Russia’s Ground Combat Capabilities and Implications for U.S.-Russia Competition, Santa Monica, Calif.: RAND Corporation, RR-3099-A, 2019. For questions about this analysis, contact Andrew Radin at aradin@rand.org.

[www.rand.org/t/RR3099](www.rand.org/t/RR3099)
REPORT SUMMARY

SOF operations need to be assessed continually to understand their effectiveness and to support ongoing operational planning. Effective operational assessments are rigorous, unbiased, and timely. They provide commanders with a clear and compelling picture of the effects being achieved and not achieved. Knowing where SOF efforts are producing results and where they are falling short helps commanders choose the best possible path forward.

Operational assessments are challenging for all forces, but SOF-deployed headquarters face particular challenges. SOF operations are often very dynamic and may be conducted in denied environments. Moreover, their effects are often achieved indirectly, through partner forces, and in the realms of attitude and affect. Moreover, deployed SOF headquarters are small and have relatively few personnel to assign to assessment activities.

An Innovative Approach to Assessment
To address these SOF assessment challenges, RAND Arroyo Center developed a new methodology that capitalizes on novel and creative ways of analyzing operational and ambient data.

Operational data are those that the headquarters and other military elements already produce as part of their operations. Sources of operational data include situation reports (SITREPs), intelligence reports, and concepts of operations. These data provide geographically and temporally precise information about unit activities, the operational environment, and how both are evolving. Because they provide highly granular information about specific operational activities, these are powerful longitudinal data sources for assessments.

Ambient data are typically produced and collected by nonmilitary entities where military operations are being conducted. Sources of ambient data include social media and other digital communication, satellite-based imagery (e.g., agricultural production), and traditional media (e.g., newspapers). These data provide a way to measure morale among partner forces, enemy elements, and civilian populations; evaluate changes in economic activity or movements of people; and assess perceptions.

Because these data sources produce large volumes of data, powerful tools are needed to analyze the data with speed and rigor. The new methodology capitalizes on recent developments in computational analysis.

KEY POINTS

- Special operations forces (SOF) operations need to be assessed continually to understand their effectiveness, justify their continuation, and inform planning.
- Conducting operational assessments is particularly challenging for deployed SOF headquarters with small staffs.
- Implementing a new assessment methodology would enable SOF staffs to conduct rigorous and timely operational assessments.
- A new seven-step methodology draws on diverse sources of data, including social media, and applies advanced analytic methods, including computational text analysis and social network analysis.

Measuring the Effectiveness of Special Operations

SOF operations need to be assessed continually to understand their effectiveness and to support ongoing operational planning. Effective operational assessments are rigorous, unbiased, and timely. They provide commanders with a clear and compelling picture of the effects being achieved and not achieved. Knowing where SOF efforts are producing results and where they are falling short helps commanders choose the best possible path forward.

Operational assessments are challenging for all forces, but SOF-deployed headquarters face particular challenges. SOF operations are often very dynamic and may be conducted in denied environments. Moreover, their effects are often achieved indirectly, through partner forces, and in the realms of attitude and affect. Moreover, deployed SOF headquarters are small and have relatively few personnel to assign to assessment activities.

An Innovative Approach to Assessment
To address these SOF assessment challenges, RAND Arroyo Center developed a new methodology that capitalizes on novel and creative ways of analyzing operational and ambient data.
Computational text analysis allows the user to analyze more text than human beings can usefully read. A large percentage of military operational data (e.g., SITREPs) come in the form of semistructured or unstructured text that is amenable to computational text analysis. To analyze social media data, text analysis can be combined with social network analysis to examine how communities interact with each other. Even nontextual data are now amenable to machine-learning and artificial-intelligence approaches for classification and analysis. Emerging analytic tools for images, audio, and video promise to provide additional insights into the cognitive states, emotions, and communication of enemy and host-nation populations.

### A Seven-Step Methodology

The Arroyo-developed assessment methodology is divided into seven sequential steps, summarized in the table. The methodology guides assessment teams in the collection of data, selection of appropriate analytic techniques, and development of visualizations that communicate consolidated results to commanders and planners.

SOF operational plans commonly specify multiple lines of effort (LOEs). The assessment methodology is designed around the four LOEs that underpin the vast majority of operations conducted by SOF operational-level headquarters:

- **Develop, enable, and employ partner forces.** This LOE includes recruiting, training, equipping, advising, and sustaining partner forces (both state and nonstate actors).
- **Precision targeting.** This LOE is the use of both direct action and counternetwork activities to degrade or suppress enemy forces, which can either eliminate a specific threat or create time and space for other operations.
- **Influence via military information support operations.** This LOE influences the attitudes and behaviors of key individuals or populations—including the enemy, partner forces, and civilians—using a diverse range of media and related tools.
- **Influence via civil affairs operations.** This LOE identifies and mitigates underlying causes of instability within civil society, thus enhancing the legitimacy of a governing entity and limiting the freedom of maneuver for enemy elements.

A key component of the methodology is the careful development of measures of effectiveness (MOEs) to help gauge whether objectives are being obtained along each of the LOEs. The methodology also encourages the assessment of each MOE using multiple data sources and analytical methodologies, a process called *triangulation*. Triangulation allows the assessors to cross-validate findings and increases confidence in the assessment results.

### Implementation

To implement the new assessment methodology, SOF will need to make changes across the spectrum of doctrine, organization, training, material, leadership development and education, personnel, facilities, and policy. Implementation will include incorporating the approach into doctrine and training and having the organizational dedication to stand up an assessment cell. Sufficient facilities and material support—including access to data streams and appropriate analytic platforms and reachback support—are vital as well.

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**NOTE:** LOE = line of effort; MOE = measure of effectiveness.
Because the United States is committed to ensuring the security of its allies and partners, it invests substantial resources in maintaining an overseas military presence to help deter attacks by adversarial states. Yet both policymakers and defense analysts debate basic questions regarding the positioning of American military forces outside the continental United States. How effectively do forward-positioned forces contribute to international stability? What types of forces work best to deter interstate aggression? On what scale must they be deployed? Where should they be stationed?

To help answer such questions, RAND Arroyo Center analyzed the relationships between overseas deployments of conventional U.S. military forces and occurrences of interstate conflict since World War II.

**Capabilities, Conflicts, and Crises**
To understand the relationship between U.S. presence and interstate conflict, the Arroyo team needed to develop reliable ways to measure each.

**KEY POINTS**
- Forward stationing heavy ground combat forces near or within U.S. partners and allies appears to help deter adversarial states from attacking them.
- Forward stationing more-mobile forces, including air and naval, is associated with fewer measurable deterrent effects.
- Forward stationing light ground combat forces may increase the risk of low-level militarized incidents, especially if those forces are stationed directly within the U.S. partner to be defended.
- Surging U.S. military forces forward in response to international crises is associated with a lower risk of escalation to major violence, but it might not help the defended partner or ally achieve better strategic outcomes.

**The Deterrent Impact of U.S. Overseas Forces**
To measure U.S. overseas military presence, researchers created a comprehensive data set of all conventional U.S. military forces deployed annually, both those permanently stationed abroad and those surged forward in response to international crises. They examined military capabilities in eight categories:
- heavy ground combat forces, including armored, mechanized, artillery, and aviation units
- light ground combat forces, including light infantry, airborne, and some special forces units
- air defense artillery, counting only stand-alone units
- other ground forces, including support units, such as logistics and engineer units
- U.S. Air Force (USAF) fighter aircraft
- USAF bombers
- other USAF personnel, including support staff, intelligence, and commands
- U.S. Navy carrier strike groups.
These data were collected through extensive historical research involving dozens of sources on U.S. military deployments across all services, dating back to 1946.

To measure the incidence of interstate conflicts, the research team considered not only wars but also lower-level militarized interstate disputes (MIDs), including threats and displays of force. Interstate wars have been rare since World War II, but lower-level MIDs have been common. The team also gathered data on 259 international crises between states since World War II.

The richness of data on deployments and militarized disputes enabled the researchers to use statistical modeling to assess the relationship between U.S. force presence and the likelihood of conflict. The statistical models assessed the likelihood that an aggressive adversary (State A in the figure) would initiate hostilities against a U.S. partner or ally (State B), dependent on the presence of U.S. forces within or nearby the defender (States B, C, and D).

**Evidence of Effective Deterrence**

Overall, the statistical analyses supported the general conclusions of previous studies of deterrence while also adding considerable nuance to the understanding of the potential deterrent—or escalatory—effects of specific military capabilities.

In the case of U.S. military forces permanently positioned forward, at least some types of capabilities are associated with deterrent effects. In particular, the forward stationing of heavy ground combat forces near or within U.S. partners and allies is associated with a lower risk that adversarial states initiate high-intensity MIDs, including war.

More-mobile military capabilities are associated with less evidence of deterrent effects, perhaps because adversaries interpret them as signaling less resolve on the part of the United States or because their effects are more difficult to measure. For example, USAF fighters forward stationed near partners and allies are chiefly associated with a lesser risk of low-intensity MIDs. Naval forces, which are highly mobile, are not associated with any measurable deterrent effects.

However, light ground forces stationed nearby are not associated with any deterrent effect, and they may be associated with an increased risk of escalation. This escalatory effect may be more pronounced if the troops are instead stationed directly within the U.S. partner to be defended.

In the case of U.S. military forces surged forward in response to a crisis, these forces are associated with a lower likelihood of escalation to major violence, although the findings are based on relatively few cases: The United States has surged military forces forward to intervene in only 21 of 259 international crises, most commonly relying on naval forces and rarely on ground combat forces. Although these forces may help deter escalation, they do not appear to be associated with better postcrisis strategic outcomes for the state the United States sought to support.

**A Major Consideration Clarified**

Using statistical analyses of the historical record, this study offers insights into how the United States can help deter aggression against its allies and partners by forward positioning conventional military forces. Although deterrence is only one of many considerations that bear on a decision to position U.S. military forces abroad, these insights can help policymakers and planners weigh the deterrent benefit more accurately against costs and risks and make evidence-based choices in each specific case.

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This summary is based on Bryan Frederick, Stephen Watts, Matthew Lane, Abby Doll, Ashley L. Rhoades, and Meagan L. Smith, *Understanding the Deterrent Impact of U.S. Overseas Forces*, Santa Monica, Calif.: RAND Corporation, RR-2533-A, 2020. For questions about this analysis, contact Bryan Frederick at bfrederic@rand.org. [www.rand.org/t/RR2533](http://www.rand.org/t/RR2533)
The U.S. Army uses the term collective training to refer to events in which units of soldiers learn, practice, and demonstrate proficiency in group tasks key to missions. A collective task—such as moving in formation—typically involves complex perceptual, decisionmaking, communication, and coordination activities.

To provide collective training efficiently and effectively, the Army augments live events with simulation-based training (SBT). For decades, armor and aviation units have conducted collective SBT on physical simulators, dedicated devices that resemble actual Army systems. Increasingly, units have also conducted SBT on virtual, game-based combat simulations running on networked personal computers (PCs).

Compared with physical simulators, virtual simulations are clearly less expensive to procure, operate, and upgrade, and they are more accessible to trainees. However, some stakeholders also consider virtual SBT less effective because it lacks the “look and feel” of training inside a vehicle mock-up.

### KEY POINTS

- For decades, Army armor and aviation units have conducted some collective training via physical simulators but increasingly have used virtual simulators, which are less expensive to procure, operate, and upgrade and are more accessible to trainees.
- Although virtual simulators lack physical fidelity, they can provide a high level of psychological fidelity—that is, they can prompt relevant responses from trainees—which is key to effective training.
- The Army can transition to virtual simulators for collective training by investing in training support packages consisting of curricula that promote psychological fidelity and facilitate learning and evaluation criteria to assess training effectiveness.

### How Should the Army Use Simulators to Conduct Collective Training?

The U.S. Army uses the term collective training to refer to events in which units of soldiers learn, practice, and demonstrate proficiency in group tasks key to missions. A collective task—such as moving in formation—typically involves complex perceptual, decisionmaking, communication, and coordination activities.

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#### Fidelity in Training

To examine the relationship between simulator fidelity and training effectiveness, RAND Arroyo Center researchers reviewed relevant studies of group training in many settings. Generally, simulator fidelity is defined as the degree to which a simulator or simulation replicates real-world equipment, environments, and tasks. Researchers frequently distinguish three types of simulator fidelity:

- **Physical fidelity** is the degree to which simulators capture the “look and feel” of a system or environment.
- **Functional fidelity** is the degree to which a simulator responds to the user’s actions in realistic ways or replicates functions of the actual equipment.
- **Psychological fidelity** is the degree to which the simulator or simulation prompts cognitive, behavioral, and emotional responses relevant to performance in a particular setting.
Training simulators with low physical fidelity and high psychological fidelity can be effective yet relatively inexpensive

<table>
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<th>Psychological fidelity</th>
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<th>May be overvalued by users</th>
<th>Effective</th>
<th>Relatively expensive to develop and update but may be overvalued by users</th>
<th>Relatively inexpensive but may be undervalued by users</th>
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<tr>
<td>Low</td>
<td>Low</td>
<td>Not effective</td>
<td>Relatively inexpensive but may be undervalued by users</td>
<td>Not effective</td>
<td>May be overvalued by users</td>
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</tbody>
</table>

Studies have consistently concluded that high physical and high functional fidelity do not necessarily enable better training. Rather, psychological fidelity is key. Simulators with low physical fidelity can provide effective training if psychological fidelity is high (see figure). This is especially the case for training on collective tasks that involve largely cognitive skills, such as monitoring others’ actions and synchronizing activities.

These findings suggest that Army stakeholders who prefer physical simulators over virtual simulators for training units on collective tasks may be overvaluing physical fidelity. Although high physical and high functional fidelity contribute to psychological fidelity, they are not required. Psychological fidelity is created largely through training strategy and instructional design.

Simulators for Combined Arms Training

Arroyo also compared the fidelity, effectiveness, usage, and cost of two physical and virtual simulators that the Army currently uses to train collective tasks.

The two physical simulators are the Close Combat Tactical Trainer (CCTT) and Aviation Combined Arms Tactical Trainer (AVCATT), used to train collective tasks for Army armor and aviation units, respectively. Units train on CCTT and AVCATT in large facilities containing multiple modules, each representing a single vehicle or aircraft.

These were compared with Virtual Battlespace 3 (VBS3), a game-based, semi-immersive virtual simulation that the Army also uses to provide collective training. VBS3 runs on networked PCs and does not offer the physical fidelity of CCTV and AVCATT modules, although the PCs can be arranged to replicate how soldiers would be seated in actual crew spaces.

Arroyo engaged Army personnel who develop, deliver, and receive training to learn how they view the relative advantages and disadvantages of the physical versus the virtual simulation. Stakeholders viewed CCTT and AVCATT as important for collective training and valued their physical fidelity; however, physical realism was considered a liability when modules are not up-to-date, because soldiers may make mistakes following training when they operate currently fielded equipment. Although some stakeholders recognized the value in virtual simulation for collective training, the Army training community continues to emphasize the value of physical fidelity, as reflected in acquisition and support of physical simulators and the relative lack of awareness of virtual SBT or emphasis on instructional design and evaluation to support training collective skills.

Managing a Transition to Virtual Simulators

The researchers concluded that the Army could prudently replace physical simulators for collective training, such as CCTT and AVCATT, with semi-immersive virtual simulators. At the same time, the Army should invest more in training support packages to foster psychological fidelity and facilitate and evaluate learning. This would include designing training scenarios to elicit the behaviors required in collective tasks, particularly opportunities for decisionmaking, and developing standardized assessments that provide feedback to trainees.

Arroyo also recommended conducting research to demonstrate that, if collective training were designed and supported appropriately, shifting from physical simulators to virtual SBT would reduce costs for training equipment and facilities substantially and provide more opportunities for practice, which are essential for skill mastery and retention.

This summary is based on Susan G. Straus, Matthew W. Lewis, Kathryn Connor, Rick Eden, Matthew E. Boyer, Timothy Marler, Christopher M. Carson, Geoffrey E. Grimm, and Heather Smigowski, Collective Simulation-Based Training in the U.S. Army: User Interface Fidelity, Costs, and Training Effectiveness, RR-2250-A, 2019. For questions about this analysis, contact Susan Straus at sgstraus@rand.org. www.rand.org/t/RR2250
Helping Army Spouses Address Life’s Challenges

The U.S. Army prioritizes care of its personnel, and this priority extends to their spouses and families. Army families face all the usual stresses and strains of civilian families in addition to the distinctive challenges of military life, such as deployments and frequent relocations. To help Army families deal with these challenges, the Army and the Department of Defense provide a wide range of programs and services.

To inform these ongoing efforts, in 2018 RAND Arroyo Center researchers surveyed 8,500 Army spouses to gain their firsthand perspectives of the problems spouses considered most important, the types of help they needed to address the problems, their experiences with resources they contacted for assistance, and the match between the resources available and the challenges they face. The survey also analyzed how spouses’ problems and efforts to address them were related to their well-being and their attitudes toward military life, including their support for the soldier spouse remaining in the Army (see figure).

Army Spouses Seek Help with Many Kinds of Problems

Almost all Army spouses who participated in the survey reported experiencing challenges of various types in the previous year. The most common specific issues selected among 96 options were feeling overwhelmed—both the spouse and the soldier—and loneliness. Difficulty figuring out where to go and whom to talk to for help or information was also a commonly experienced challenge.

When asked to prioritize their most-pressing problems, spouses most frequently identified the areas of work-life balance, military practices and culture, and their own well-being.

Almost one-fifth of spouses with problems reported needing no help to address them. Among the majority who did need help, emotional and social support was the most frequently chosen top need. Spouses of junior enlisted soldiers were more likely to report a need for general information, particularly for problems with military practices and culture.

KEY POINTS

- The most-pressing problem areas reported by Army spouses were work-life balance, military practices and culture, and their own well-being.
- The majority of Army spouses reported seeking assistance with their problems from one or more military and nonmilitary resources, and the most common reason for not using resources was not knowing whom to contact.
- When Army spouses used resources to help with their needs, most had their needs met, but 32 percent reported having unmet needs even after using resources.
- The Army should increase direct outreach to spouses and take steps to improve their awareness and navigation of resources.
Despite Many Resources, Some Needs Remain Unmet

Almost all Army spouses with problems and needs sought help from military and nonmilitary resources. The most common reason for not using resources was not knowing whom to contact for help. Spouses who used resources reported consulting more than four resources for each top problem.

The most commonly used official military resources were medical providers, the internet, and social media. Only 15 percent of spouses contacted an Army Family Readiness Group (FRG).

Most Army spouses also sought help from nonmilitary resources. Just over half of spouses contacted their personal networks outside the military for help, and 43 percent contacted other military spouses they knew personally.

When Army spouses used resources to help with their needs, most had their needs met, but 32 percent reported having unmet needs even after using resources. This equates to 22 percent of the entire population of participating spouses having no unmet needs (i.e., including those who never reported having problems or needs). The problem areas with highest rates of unmet needs were military practices and culture and health care system problems.

Army spouses who had unmet needs reported the most stress, the least-positive attitudes toward the military, and the least support for their soldiers staying in the Army. Spouses who had difficulty finding resources because they did not know whom to turn to for help experienced more stress and less positive attitudes toward the military than those who used resources and had their needs met.

Generally, spouses who lived farther from post and spouses of junior enlisted soldiers were less comfortable using military resources and navigating the military resource system.

The Army Can Increase Outreach and Improve the Navigation of Resources

On the basis of these findings, Arroyo researchers recommended ways the Army could improve awareness, delivery, and assessment of its many family-oriented programs and services. For instance, the Army could try to increase participation in FRGs, especially by spouses of junior enlisted soldiers and those who live far from their soldiers’ military posts. To facilitate outreach, the Army could systematically collect or provide email addresses for spouses. To improve awareness and navigation of all available military resources, it could encourage the use of helplines, employ relatively popular resources to alert spouses to less well-known resources, and implement a “no wrong door” policy to steer spouses to the resources best suited to their needs for assistance. A system to elicit spouse feedback would be valuable to inform the evaluation and monitoring of programs and services.

This summary is based on Thomas E. Trail, Carra S. Sims, and Margaret Tankard, Today’s Army Spouse Survey: How Army Families Address Life’s Challenges, RR-3224-A, 2019. For questions about this analysis, contact Thomas Trail at ttrail@rand.org.

www.rand.org/t/RR3224
Each year, the U.S. Army decides how many soldiers it would like to enlist—a goal referred to as the mission—and allocates resources to achieve that recruiting mission. This is done without regard to whether recruiting conditions in the future are likely to be easy or difficult. As a result, recruiting resources may be insufficient when the recruiting environment is difficult and overly abundant during periods of easier recruiting. Once the Army recognizes that recruiting conditions have become difficult, it can respond by reprogramming resources and adjusting policies, but many of the Army’s recruiting tools (e.g., recruiters, advertising campaigns) take time to develop to become fully productive.

If the Army had a way to forecast recruiting conditions accurately a year or two into the future, it could proactively use those forecasts to adjust budgets and policies and help ensure that it will meet its mission despite a difficult recruiting environment.

RAND Arroyo Center developed an empirical, data-driven model—the recruiting difficulty index (RDI)—that can provide such forecasts, offering Army leadership an “early warning system” for recruiting difficulty.

Indicators of Recruiting Difficulty
When recruiters are on track to meet the overall mission but are falling short on high-quality recruits (referred to as graduate alphas [GAs]), that can be an early indication that the recruiting environment is becoming difficult. The RDI calculates the Army’s success in recruiting GAs as the primary measure of recruiting difficulty, holding constant the educational and test score standards.

The RDI augments the primary measure with two additional measures that help confirm that the recruiting environment is difficult (or easy): the number of recruits waiting to
ship to training (called the Delayed Entry Program [DEP]) and the number of vacant training seats.

Multiple measures provide progressively stronger signals of recruiting difficulty. Shortfalls in meeting mission for GA recruits will warn of recruiting difficulties within two to three months. The length of time in DEP takes longer to signal a problem. After a period of shortened DEP lengths, the Army will begin to fail to fill training seats. That is a sign that the Army’s recruiting environment has become severely difficult.

**Policy Levers**

The RDI includes variables to take into account four policy levers that the Army can adjust to recruit effectively in a difficult recruiting environment:

- **Increase the number of recruiters.** With more recruiters on duty, more prospects can be located, informed, and persuaded to enlist.

- **Offer “quick-ship” bonuses.** The Army can offer recruits a monetary bonus to access into the Army very quickly—i.e., within a month after signing a contract. This lever can help reduce vacancies at basic training stations.

- **Offer enlistment bonuses for some military occupational specialties.** This lever can help increase recruits in occupations that are in short supply (usually because of difficult entrance requirements) or that face competition with civilian opportunities, such as cyber-related occupations.

- **Increase the use of conduct waivers.** Potential recruits may fail to meet Army enlistment standards for upstanding conduct. A flexible use of waivers can enable some prospects to enlist despite prior conduct problems, such as misdemeanors and multiple driving offenses.

**Economic and Geopolitical Factors**

The RDI also includes variables that take into account external factors that may affect recruiting difficulty and are outside the control of the military (see figure). When deciding whether to enlist in the Army, young people may consider their job prospects in the civilian world, the likelihood that they may be deployed if they serve, and the likelihood that they may be injured or killed in combat if they deploy.

To account for these considerations, the RDI includes variables on economic conditions, geopolitical risks, and deployment-related injury and death rates. Each of these variables is a carefully constructed composite of several indicators for which high-quality monthly data are available. For instance, the health of the economy is represented as a composite of the unemployment rate for young adult males, housing starts, and consumer sentiment.

**To test the RDI, Arroyo estimated the model using historical data from 2003 to 2015 and then predicted recruiting difficulty in 2016. The prediction closely matched the actual recruiting outcomes of that year for the recruiting difficulty measures, demonstrating that the RDI produced valid and accurate forecasts. The model was then used successfully to forecast that the Army would face a very challenging recruiting environment in fiscal year 2017. The model can be recalibrated to predict recruiting difficulty during and after the COVID-19 pandemic.**

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This summary is based on Jeffrey B. Wenger, David Knapp, Parag Mahajan, Bruce R. Orvis, and Tiffany Tsai, Developing a National Recruiting Difficulty Index, RR-2637-A, 2019. For questions about this analysis, contact Jeffrey Wenger at jbw@rand.org.

[www.rand.org/t/RR2637](http://www.rand.org/t/RR2637)
In 2016, the Office of the Under Secretary of Defense (Comptroller) (OUSD(C)) asked the military departments to increase the transparency of accounting practices and improve auditability by minimizing the use of “reimbursables” to pay for civilian personnel costs. Reimbursable activities are funded by charging customers for the costs of the services they receive. This makes transactions between organizations less transparent and harder to trace, as funding is transferred from one organization to another. Reimbursables could also result in the double counting of funding, since both the customer and the supplier are obligating the same funds.

In response to the OUSD(C) request, the Office of the Deputy Chief of Staff, G-8, U.S. Army, asked RAND Arroyo Center to evaluate alternative approaches to funding the activities of CCDC and ATEC, both of which rely on reimbursables for approximately half of their funding.¹

Alternative Funding Models
Arroyo researchers assessed four funding models that vary by whether customers pay for direct costs (those costs closely linked to a specific effort or customer) and whether customers are taxed indirect rates to pay for the command’s indirect costs.

KEY POINTS
• The Department of Defense recognizes that the use of customer reimbursables to fund some activities can complicate accounting, auditing, and oversight.
• Army organizations that rely strongly on reimbursables for funding include the Combat Capabilities Development Command (CCDC) and Army Test and Evaluation Command (ATEC).
• These Army organizations should not change their funding models, but they should take other steps to facilitate accounting and auditing.
• Reforms should focus on increasing the transparency of indirect rates and standardizing reimbursable policies and practices.

¹In February 2019, U.S. Army Research, Development and Engineering Command (RDECOM) was renamed the Combat Capabilities Development Command (CCDC) as it transitioned from the Army Materiel Command to Army Futures Command. The research summarized here was conducted in 2017 and 2018 and does not reflect changes made after CCDC transitioned.
costs (costs that organizations cannot link to specific efforts or customers, such as overhead):

- **Full cost recovery**: In this model, direct costs are reimbursable from customers or funded with appropriations; indirect costs are paid by taxing all direct work.

- **Working capital fund (WCF)**: WCFs offer full cost recovery and are exempt from OUSD(C) guidance about reducing reimbursables but are subject to Department of Defense standards in pricing, cost recovery, and reporting.

- **Appropriations for indirect costs**: This model pays direct costs with customer reimbursables and pays indirect costs with appropriations.

- **Full appropriations**: This model pays for both direct and indirect costs with appropriations, without the use of reimbursables.

Commands may blend these funding models. ATEC’s test capabilities at Redstone Test Center (RTC) use (near) full cost recovery, whereas its Major Range and Test Facility Base (MRTFB) test ranges are required by law to use appropriations for indirect costs. CCDC uses the full cost recovery model blended with both the appropriations models: To pay for direct costs, CCDC uses funding from both customers and from appropriations, and it pays for indirect costs using funding from taxes on customers and from appropriations.

### New Funding Models Are Not Advised

Arroyo concluded that both CCDC and ATEC are currently using appropriate funding models, although each could undertake reforms to improve transparency. Two of the four alternative funding models, full appropriations and WCF, have substantial drawbacks that would preclude them from adoption by CCDC and ATEC (see the table).

Moving to a full appropriations model would eliminate the use of reimbursables and address most financial and accounting concerns. However, it is an inappropriate model for customer-supplier relationships. It would reduce the ability of commands to pivot resources and adapt to changing customer and Army priorities; would provide services “free” to customers, leading to capacity shortfalls; and might reduce or eliminate the incentive to be responsive to customer and Army needs.

The WCF model is exempt from the guidance to minimize reimbursables, and this model would be feasible for CCDC and ATEC RTC, but the costs and risks of such a change likely outweigh the benefits. It would probably not address many financial and accounting transparency concerns, and it would likely raise customer prices, leading to customers reducing demand and CCDC and ATEC divesting of capabilities. ATEC could not move its MRTFB ranges to a WCF without changes to current laws and policies.

### Reforms to Improve Transparency and Auditability

CCDC and ATEC should continue to operate their current funding models despite the reliance on reimbursables, but they should change accounting and business practices to improve transparency and auditability.

For instance, the Army should improve the transparency of indirect rates at CCDC and ATEC’s non-MRTFB capabilities to address a major criticism of reimbursable funding. The Army should also increase the consistency of financial policies and standardization of reimbursable practices to address concerns that customers are treated differently.

By focusing on improvements within their current funding models, CCDC and ATEC can address stakeholder financial and accounting concerns while avoiding the drawbacks and risks of moving to alternative funding models.

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**Funding models CCDC ATEC MRTFB test capabilities ATEC non-MRTFB test capabilities**

<table>
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<tr>
<th>Funding models</th>
<th>CCDC</th>
<th>ATEC MRTFB test capabilities</th>
<th>ATEC non-MRTFB test capabilities</th>
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<tr>
<td>WCF</td>
<td>Feasible but has drawbacks</td>
<td>Not feasible: Requires policy or law change</td>
<td>Feasible for RTC but has drawbacks</td>
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<td>(Near) full cost recovery</td>
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<td>Full appropriations</td>
<td>Inappropriate for customer-supplier relationships</td>
<td>Inappropriate for customer-supplier relationships</td>
<td></td>
</tr>
</tbody>
</table>

**NOTES**: Shading indicates funding models assessed during the 2017–2018 study. CCDC = Combat Capabilities Development Command; ATEC = Army Test and Evaluation Command; MRTFB = Major Range and Test Facility Base; WCF = working capital fund; RTC = Redstone Test Center.
During the Iraq War and operations in Afghanistan, soldiers in U.S. Army supply convoys sustained substantial casualties as they traversed hundreds of miles on largely unsecured routes. Automating Army trucks would help remove soldiers from such dangers in future wars.

Robotic ground vehicles are maturing quickly in commercial applications, and the Army research and development community is testing automated and even fully autonomous trucks. RAND Arroyo Center examined how the Army should proceed with its development and integration of automated-driving technology for supply convoy operations in the near future.

**Autonomous Convoy Concepts**

Arroyo researchers compared three autonomous convoy concepts, representing different levels of technological maturity and reliance on human operators:

- **Fully autonomous employment**: Army cargo trucks would be fully autonomous, although accompanied by manned gun trucks for protection. Remote operators would monitor the convoy’s progression and assume control of cargo trucks when their automation is unable to negotiate the driving conditions.

- **Partially manned employment**: Automated unmanned cargo trucks would follow the path of a lead manned cargo truck.

- **Minimally manned employment**: In this Arroyo-developed employment concept, a lead cargo truck would provide the driving path for following cargo trucks, driven by an automated system. Each cargo truck would have a single human operator, who would monitor the automated system and driving environment and assume control when the driving conditions are complex.

**KEY POINTS**

- Automating Army vehicles would reduce the number of soldiers in harm’s way.
- Autonomous-vehicle technology has matured sufficiently to support the Army’s development of minimally manned supply convoy operations, in which automated trucks would each be manned by a single human operator, who could take control when driving conditions are complex.
- The success of minimally manned convoy operations depends strongly on the design of the human-to-machine interfaces.
- The Army should develop minimally manned convoy operations as a bridge toward partially manned operations, in which unmanned trucks would follow the path of a lead manned truck.
The researchers assessed the technical feasibility of these concepts, given the current and projected maturation of automated-driving technologies. Fully autonomous employment is not feasible in the near term, except on test tracks, and must remain a long-term goal. The partially manned employment concept is currently feasible but only for highway driving under ideal conditions. By comparison, the minimally manned employment concept may be ready for integration into highway, urban, and trail driving.

**Less Vulnerable, More Efficient Convoys**

Arroyo researchers analyzed the benefits, risks, and implications of each employment concept. Compared with the status quo of fully manned convoy operations, each concept would substantially reduce the number of personnel required; because of this reduction, the convoys would also be more efficient, offering a higher throughput (in terms of flat racks of supplies) per soldier (see the table).

Automated trucks would decrease the demand for entry-level drivers but increase demand for more-senior drivers who have the experience to take over control from autonomous driving systems in complex conditions. The technological sophistication of the driving technologies would also change the skills required for the maintenance and repair of supply trucks. These shifts in personnel demand would change the force structure requirements, training, and recruiting for relevant military occupational specialties.

**Strong Human-Machine Interfaces**

The partially manned and minimally manned concepts have similar technical requirements. Both include human operators in the convoy who would provide a level of redundancy and robustness to compensate for automated technology’s shortcomings. But the minimally manned concept presents substantially lower technical risks, primarily because it includes a soldier in each truck cab.

The successful employment of these manned concepts for autonomous convoy operations depends strongly on effective human factor design. Human-machine interfaces of concern include not only the interface in the cab between the soldier operator and the autonomous-driving system but also the interfaces between leader and following trucks and between following trucks and surrounding traffic and pedestrians.

**A Bridge to Fully Autonomous Convoys**

The transition from fully manned to autonomous convoys must be staged. Even in the midterm, the Army will not be able to implement a fully autonomous employment concept for supply convoys in deployed operations. Arroyo developed the minimally manned employment concept to provide a feasible and prudent bridge to a partially manned concept. The minimally manned concept is congruent with the current state-of-the-art of robotic driving and would begin to achieve the Army’s goal of removing soldiers from harm’s way. Moreover, its implementation could help the Army progress more rapidly to a partially manned concept. The Army could use minimally manned convoys to generate data to help improve and mature autonomous-driving systems to the point at which a soldier operator could be safely removed from the cab.

Automated convoys have the potential to deliver substantial benefits to the Army, but they will also bring about dramatic changes to how the Army conducts its combat logistics operations. Each autonomous-convoy concept would require changes to convoy tasks, training, and organizational structure. A staged approach to the integration of autonomous-driving technology into supply convoys would give the Army time to prepare for the inevitable long-term force structure and personnel impacts.

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www.rand.org/t/RR2406
The U.S. Army fields a wide variety of artillery systems at various echelons, from the battery to the field artillery brigade, including howitzers, rockets, and missiles. The mission of the Field Artillery Branch is to destroy, defeat, or disrupt the enemy with integrated fires to enable maneuver commanders to dominate in unified land operations. Despite the importance of this mission, the Army decreased its field artillery force structure by roughly 50 percent from 2004 to 2011, when the U.S. military was focused on counterinsurgency operations in the Middle East and Southwest Asia.

By contrast, substantial advances have occurred in the field artillery of potential adversaries, including Russia, North Korea, Iran, and China. Because the Army’s Field Artillery Branch is currently at a low point in terms of its capacity and capabilities, it would face substantial challenges in combat operations against high-quality adversarial forces.

**Key Points**

- The Army’s Field Artillery Branch is currently at a low point in terms of its capacity and capabilities and would face substantial challenges in combat operations against high-quality adversarial forces.
- Depending on the scenario, these challenges could include being outnumbered and outranged, lacking effective targeting or appropriate munitions, and being vulnerable to enemy fires.
- The Army should strengthen its artillery capacity and capability by increasing the number of systems and improving their range, rate of fire, precision, and munitions.
- Improvements in targeting, coordination of joint and coalition fires, and survivability are also needed.

**Army Fires Capabilities for 2025 and Beyond**

The U.S. Army fields a wide variety of artillery systems at various echelons, from the battery to the field artillery brigade, including howitzers, rockets, and missiles. The mission of the Field Artillery Branch is to destroy, defeat, or disrupt the enemy with integrated fires to enable maneuver commanders to dominate in unified land operations. Despite the importance of this mission, the Army decreased its field artillery force structure by roughly 50 percent from 2004 to 2011, when the U.S. military was focused on counterinsurgency operations in the Middle East and Southwest Asia.

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**Challenges Vary by Adversary**

In a conflict with Russia, U.S. ground fires would risk being significantly outnumbered. The Russian Army has deployed large numbers of cannons and rocket launchers at the brigade and battalion tactical-group levels. Russian forces also have the capabilities to limit U.S. target acquisition systems.

In potential conflicts with China or Iran, artillery range would be the key challenge. In an Iranian scenario, the U.S. Army might need to deliver substantial amounts of accurate, long-range fires across the Persian Gulf and Strait of Hormuz and might also have difficulties in coordinating with other Gulf states. In a conflict with China, U.S. ground fires would require a much longer-range fire system than the Army currently fields, as well as an anti-ship capability.

In conflicts with other adversaries, appropriate munitions would be a key challenge. North Korean cannons and rocket
launchers can fire and rapidly return to well-constructed underground positions, and the U.S. Army currently lacks munitions capable of penetrating these. In a conflict with the Islamic State or similar organization, the Army would need highly precise munitions to provide fire support in urban areas without causing excessive collateral damage.

**Critical Gaps in Targeting**

The ability to locate and target enemy forces is essential to delivering timely and accurate fires. In operations against irregular forces or regional powers fielding air defense systems that are less than state-of-the-art, the U.S. Army should be able to maintain its recent success at locating, identifying, and targeting through 2025. However, against a peer competitor, the Army’s primary targeting platforms may be denied access to enemy territory or destroyed by enemy indirect fires. The inability to access intelligence, surveillance, and reconnaissance data quickly and reliably from the U.S. Air Force’s fifth-generation aircraft, such as the F-22 and F-35, is a critical capability gap. Another related gap is the present inability to seamlessly exchange data to support targeting, deconfliction, and mission command with ally and partner forces.

**Many Changes Are Needed**

To avoid the Field Artillery Branch being outnumbered and outgunned in future conflicts, the Army needs to undertake many changes:

- It should increase the Field Artillery Branch force structure and also increase the number of artillery units that are forward positioned or can deploy quickly.
- The Army should continually assess technology trends that could improve the effectiveness of field artillery units.
- It should modernize its cannon systems to increase their range, rate of fire, lethality, mobility, and survivability. A timely replacement for the Army Tactical Cruise Missile System (ATACMS) is needed that includes a penetrating warhead. In that regard, the ongoing development of the Precision Strike Missile as a replacement for ATACMS is a very important project for the Army.
- The Army should reduce the vulnerability and increase the survivability of artillery units against enemy indirect fires and airborne and ground threats and enhance units’ resilience against electronic warfare and cyberattacks.
- The Army should also improve its target acquisition capabilities in anticipation of advanced countermeasures, as well as its ability to quickly acquire and utilize intelligence, surveillance, and reconnaissance data from the other services.
- It should improve the ability of its artillery to provide fire support to allied and coalition partners for targeting, deconfliction, and mission command.
- The Army should develop and exercise tactics, techniques, and procedures to improve coordination with joint fires and interoperability with allied and partner forces, with a focus on conventional war with high-quality adversaries.

This summary is based on John Gordon IV, Igor Mikolic-Torreira, D. Sean Barnett, Katharina Ley Best, Scott Boston, Dan Madden, Danielle C. Tarraf, and Jordan Willcox, *Army Fires Capabilities for 2025 and Beyond*, Santa Monica, Calif.: RAND Corporation, RR-2124-A, 2019. For questions about this analysis, contact John Gordon at jgordon@rand.org.

www.rand.org/t/RR2124
ABOUT THE ARROYO CENTER

• Overview
• Arroyo Center Policy Committee
• Recent Publications
A Unique Army Resource
RAND Arroyo Center is the U.S. Army’s sole federally funded research and development center (FFRDC) for studies and analysis. FFRDCs are government-owned, contractor-operated research institutions approved by Congress to provide ongoing analytic support to a federal agency. As an FFRDC, Arroyo enables the Army to maintain a strategic relationship with an independent, nonprofit source of high-quality, objective research and analysis that can sustain deep expertise in domains of direct relevance to perennial Army concerns.

Mission
Arroyo’s mission is to conduct high-quality, objective research and analysis on major policy concerns, with an emphasis on mid- to long-term policy issues; provide short-term assistance on urgent problems; help the Army improve its effectiveness and efficiency; and be a catalyst for needed change.

Oversight
FFRDCs operate within the framework of the Federal Acquisition Regulation (48 CFR 35.017). In addition, the Army stipulates oversight and management of Arroyo in Army Regulation 5-21.3. The regulation establishes a governing board of Army leaders known as the Arroyo Center Policy Committee, co-chaired by the Vice Chief of Staff of the Army and the Assistant Secretary of the Army (Acquisition, Logistics and Technology). (See the list on page 33.)

As part of RAND, Arroyo conducts research under a “Federal-Wide Assurance” (FWA00003425) and complies with the Code of Federal Regulations for the Protection of Human Subjects Under United States Law (45 CFR 46), also known as “the Common Rule,” as well as with the implementation guidance set forth in Department of Defense Instruction 3216.02. As applicable, this compliance includes reviews and approvals by RAND’s institutional review board (the Human Subjects Protection Committee) and by the Army.

Management
At RAND, Arroyo is managed within the Army Research Division, directed by Dr. Sally Sleeper, a RAND vice president. Dr. Michael L. Hansen serves as associate director and research quality assurance manager. Jocelyn Maciol is the director of operations.
Organization

Arroyo’s research plan is managed and executed in three programs: Strategy, Doctrine, and Resources; Personnel, Training, and Health; and Forces and Logistics.

Strategy, Doctrine, and Resources Program

Directed by Dr. Jennifer Kavanagh, this program conducts research to help the Army understand the evolving strategic context, identify and adjust to external demands, and optimize the use of its resources. The program sustains research streams in seven major policy domains: competition with near-peer adversaries, operational concepts, modernization and readiness, posture and force employment, allies and partners, risk assessment and resource use, and strategic and emerging threats.

Personnel, Training, and Health Program

Directed by Dr. Heather Krull, this program focuses on policies that help the Army attract and retain the right people, train and manage them to maximize their talents, and promote their health, safety, financial security, and quality of life. The scope of the program’s analyses encompasses not only soldiers and officers and their families but also Army civilians, contractors, veterans, and retirees. The program sustains research streams in five policy domains: total workforce management, recruiting and retention, leader development, training readiness and effectiveness, and soldier and family wellness and support.

Forces and Logistics Program

Directed by Dr. Bryan W. Hallmark, this program analyzes how advances in technology, management practices, and organizational theory can be applied to Army organizations to improve operational effectiveness in current and future conflicts against adaptive adversaries, enhance logistical support to Army units, continually improve efficiency, and ensure technical and logistical readiness. The program sustains research streams in eight policy domains: understanding past, current, and possible future Army operations; understanding and improving cyber and network capabilities; improving Army acquisition and modernization; assessing and applying technology to Army combat and support operations; improving Army supply chain operations; maintaining and managing Army equipment; improving Army capabilities to deploy and sustain in operational theaters; and ensuring technical and logistics readiness.

Army Fellows Program

Each year, the Army selects a number of majors and lieutenant colonels to work at Arroyo as visiting analysts in the Army Fellows Program. This program affords officers the opportunity to increase their analytical capabilities through participation on Arroyo studies addressing critical policy issues faced by the Army. In turn, their participation enhances the Arroyo staff’s understanding of current Army policies, increases the effectiveness of site visits, strengthens projects’ analytic quality, and focuses recommendations. The one-year fellowship is followed by a three-year utilization assignment on a senior-level Army or joint staff.

Typically, the Army assigns eight to ten officers each year as fellows to Arroyo. To date, 254 officers have participated in the program.

For more information, including eligibility requirements and application instructions, see www.rand.org/ard/fellows.
Arroyo Center Policy Committee

The Arroyo Center Policy Committee (ACPC) comprises the senior Army civilian and uniformed leadership charged with oversight of RAND Arroyo Center. The Director for Program Analysis and Evaluation serves as lead agent for Arroyo and oversees its daily operations.

The ACPC meets at least twice a year with Arroyo management to provide overall guidance, review the annual research plan, and approve individual projects. Additionally, each project is sponsored by at least one Army senior leader, either a general officer or a member of the Senior Executive Service. The sponsor has responsibility for helping formulate the project, providing access to needed data and other information, monitoring progress, reviewing publications for accuracy, utilizing project findings, and implementing recommendations.

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Vice Chief of Staff, U.S. Army

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Principal Deputy Assistant Secretary of the Army (Financial Management & Comptroller)

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Assistant Secretary of the Army (Civil Works)

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The problem should be well formulated, and the purpose of the study should be clear.

The study approach should be well designed and executed.

The study should demonstrate understanding of related studies.

The data and information should be the best available.

Assumptions should be explicit and justified.

The findings should advance knowledge and bear on important policy issues.

The implications and recommendations should be logical, warranted by the findings, and explained thoroughly, with appropriate caveats.

The documentation should be accurate, understandable, clearly structured, and temperate in tone.

The study should be compelling, useful, and relevant to stakeholders and decisionmakers.

The study should be objective, independent, and balanced.

For more information, see www.rand.org/standards
The RAND Arroyo Center is the Army’s federally funded research and development center (FFRDC) for studies and analysis. Its mission is to help Army leaders make decisions that are informed by objective, high-quality analysis.

This Annual Report illustrates the depth, breadth, and responsiveness of the studies that Arroyo conducted for the Army in fiscal year 2020. The report begins by highlighting portfolios of research that support the highest priorities of Army leadership—readiness, modernization, reform, and people. It then features summaries of nine outstanding studies that demonstrate both the variety of questions posed by Army leaders and the multidisciplinary approach that Arroyo uses to answer them. The report also describes Arroyo’s organization and management and how the Army provides guidance and oversight.