



R A N D

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M A K I N G   A   D I F F E R E N C E





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RAND  
CORPORATION  

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1948 - 2023



For 75 years, decisionmakers around the world have turned to RAND for help solving the most complex and consequential public policy challenges. Through research and analysis that is empirical, nonpartisan, and objective, we strive to make communities throughout the world safer and more secure, healthier and more prosperous.

The mix of studies, singular accomplishments, and streams of research and analysis included in this book exemplifies RAND's range, originality, and influence. The selections are listed in no particular order but are intended to reflect the breadth of our increasingly diversified research agenda. Taken together, the selections reveal a common motif: our ability to have a positive impact on the world by applying rigorous and objective analysis to challenging problems. That aspiration has guided RAND ever since it was established.

If you take one thing away from this book, perhaps it will be this: Public policy need not be inaccessible. It is about real people, real places, real organizations, real solutions.

RAND's work in the public interest seeks to have a lasting positive effect on you, your family, your community, and your world.



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## COVID-19

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As hospitals filled with patients during the early days of the COVID-19 pandemic, RAND raced to develop a tool that would help them meet the surge. It was the first of dozens of research efforts that helped policymakers navigate everything from school closures to business hardships. The tool allowed hospitals to estimate how many patients they could take. They could then model increasingly drastic actions, such as assigning more patients to every nurse, to see how far they could stretch their capacity. The American Hospital Association spotlighted the tool as an early-pandemic resource for its members. Meanwhile, a second team of researchers was working to model the health and economic trade-offs of business closures and stay-at-home orders. They combined state-level data on case counts, hospitalizations, and deaths with a mathematical model of each state's economy. Their online tool allowed policymakers to toggle different social-distancing measures on or off, to see how that would affect COVID numbers on the one hand and state income levels on the other. As vaccines started to become available, RAND worked with the Centers for Disease Control and Prevention to measure public attitudes and concerns. Researchers fielded several rapid population surveys, accelerating a research process designed to produce findings in six months to one that took six days per cycle. The results directly informed critical guidance regarding COVID boosters for high-risk populations, vaccines for children and adolescents, and state vaccination programs. Separately, researchers also documented the pandemic's economic toll on families, showing that nearly one-third of all households were having trouble paying their bills. In another survey, two-thirds of teachers in high-poverty schools said at least some of their students were having trouble getting online for class. Researchers also interviewed small business owners and found widespread need for help covering rent, utility bills, and insurance. The COVID experience prompted RAND to create a rapid research response fund to continue supporting quick-turn research through the pandemic and during future times of great uncertainty.





## THE INTERNET

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The RAND Corporation was the birthplace of the internet's basic distributed network technology. In 1962, RAND borrowed ideas about rerouting and redundancy that had been developed in neurobiology and applied them to strengthening the ability of Air Force communications to survive a nuclear attack. Then, to advance what was a fairly low-tech idea, RAND added in the capabilities of digital technology that were understood only in the most advanced scientific circles. The resulting concept of “distributed communications” worked by breaking messages into smaller units of information that were sent independently through the communication system, each on the fastest path available to it, and reassembled at the end into the original message. Although there was no immediate response to the concept, years later, when the Advanced Research Projects Agency, part of the U.S. Department of Defense, began looking for an information-sharing system, it arrived at the same concept of “packet switching” for the Arpanet, which later became the internet.



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## "SLIPPERY" WATER

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In the early 1970s, when the City of New York faced dramatically escalating demands for fire service that it could not meet with existing response policies, RAND came up with several ingenious solutions. One involved adding a polymer to water to make it more “slippery” so that it ran through the hose faster, which allowed firefighters to get more water on a fire with the standard hose or the same amount of water on the fire with a smaller-diameter, lighter, and more maneuverable hose. On a more complex level, RAND developed analytical and computer simulation models capable of sorting through the myriad ways to deploy fire department resources and pinpointing the ideal response and relocation scheme. This method of allocating FDNY protection proved so effective that it has been adopted in other cities for positioning critical facilities. Thirty years later, this relocation model was an important factor in sustaining fire coverage throughout New York City when, on September 11, 2001, so many fire companies were at the World Trade Center.



## GPS

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In 1995, at the request of the White House Office of Science and Technology Policy, RAND studied the issues surrounding the 24-satellite Global Positioning System (GPS). Though operated by the U.S. Air Force and essential to military operations, GPS had become a worldwide information resource for everything from air traffic control to the internet. Balancing potentially conflicting interests related to defense, commercial, and foreign policy objectives, RAND made detailed policy recommendations designed to strengthen national security while promoting the adoption of GPS as a global standard for position location, navigation, and timing. RAND's recommendations formed the basis for a new national policy announced in 1996 by Vice President Al Gore. The national policy was updated and expanded in 2004 into a broader U.S. policy on space-based positioning, navigation, and timing; the new policy preserved the key elements of RAND's recommendations. This study helped advance U.S. leadership on this increasingly vital system and was a decisive influence in ensuring that it remained available for civil and commercial use worldwide.



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## PREVENTING TEENAGE SMOKING AND DRUG USE

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In the face of dispiriting statistics on teenage smoking and drug use, RAND set out to discover what kind of program would help young people stay away from health-damaging substances. While this program could conceivably have leaned toward law enforcement or drug treatment approaches, the data argued in favor of focusing on prevention—a significant and useful distinction. After reviewing all available research on prevention, RAND designed a prevention program for middle school youth called Project ALERT, evaluating it in two experimental field trials conducted in schools in the Western and Midwestern United States. Novel ideas bolstered the program's effectiveness. For example, instead of using lectures on the evils of drugs, Project ALERT helped students discuss who uses and why, identify internal and external pressures to use drugs, and practice ways to resist such pressures. Project ALERT, now used in schools in all 50 states, is the most widely used science-based drug prevention program in the country. There are also educators certified to deliver the program in Canada, India, Mexico, Chile, Australia, and Japan. The program is still regularly revised and updated to reflect new information, and it continues to be tested in multiyear, multicommunity studies. Named a model program by multiple governmental and private organizations, Project ALERT is listed in the National Registry of Evidence-Based Programs and Practices.





## MAXIMIZING PERFORMANCE OF U.S. AIR FORCE AIRCRAFT

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**D**ramatic technological advances in radar, navigation, and other electronic components of military aircraft after World War II had, by the early 1970s, resulted in remarkable performance capabilities in weapon systems like the F-15 and the F-16. But the very sophistication of avionics systems (“avionics” being a newly minted blend of “aviation electronics”) made them vulnerable to reliability and maintenance problems that tended to reveal themselves late in, or after, the usual period of development. RAND researchers spent years analyzing the Air Force’s avionics acquisition and support processes, seeking ways to maximize the performance designed into fighter aircraft. The result of this analysis was a comprehensive reform strategy that would mitigate the reliability and maintenance issues that plagued high-performance aircraft. The thoroughness of this research led the Air Force to initiate a specific, forward-looking program that gave higher priority to reliability and maintenance issues. Air Force acquisition procedures have become more sensitive to engineering challenges presented by sophisticated avionics systems, and the collection of valuable performance and cost data on these systems has become routine. More recently, RAND has helped the Air Force get the most out of the latest generation of fighters—the F-22 and the F-35. Numerous RAND projects have examined basing strategy, pilot absorption challenges, training requirements, force sizing, logistics, acquisition strategies, and other issues that fundamentally affect how these aircraft will operate for decades. RAND has also examined lessons from the F-22 and F-35 acquisition programs about the costs of acquiring, scheduling, operating, and sustaining future generations of fighters.



## ONE OF THE WORLD'S FIRST ELECTRONIC COMPUTERS

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In 1949, RAND researchers could not simply go out and buy the computer they needed for their increasingly ambitious analyses. They had to literally build their own. RAND's computer experts borrowed a basic design from mathematician John von Neumann, a consultant to RAND, and named their creation the Johnniac in his honor. One of only six such computers, the Johnniac was a particularly rugged and adaptable example of its type, and it became even tougher. RAND had built a special internal cooling system for the state-of-the-art vacuum tube storage system, but that technological approach to memory was prone to breakdown, prompting RAND to commission the first commercially produced magnetic core memory. The Johnniac's next major improvement was the addition of the first 140-column-wide, high-speed impact printer. The Johnniac was created as a workhorse serving RAND's analytic demands, but once the electronic computer industry kicked into gear and provided cost-effective alternatives, the Johnniac became a test bed for computer research and development. It was equipped with the first swapping drum to support the first online, time-shared conversational desktop system for individual users. The Johnniac Open Shop System (JOSS) was an elegantly designed remote-access, time-shared system that put many users in an interactive problem-solution environment on one machine. Even after it had been superseded in the commercial world, the Johnniac, through efforts like JOSS, continued to facilitate some of the most important computer improvements in the lead-up to the personal computer era. The Johnniac now makes its home at the Computer History Museum in Silicon Valley.



## EARLY CHILDHOOD INTERVENTIONS

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In light of research from neuroscience and child development demonstrating the importance of the first five years of life to physical, social, emotional, and cognitive development, a child advocacy movement emerged during the 1990s to boost government funding for early childhood programs. These programs would, it was argued, pay off in the long run by reducing the public financial burdens of welfare, criminal justice, and other expenses to which untreated childhood problems would lead. A climate of controversy developed when policymakers learned that there was little empirical evidence to support this argument. Recognizing that greater data availability would facilitate classic cost-benefit analysis, RAND researchers collected existing data on educational attainment, cognitive and behavioral assessments, economic well-being, criminal activity, and other outcomes from a number of very different early childhood intervention programs. They then calculated future government savings in all areas that could be expressed in monetary terms and compared them with the costs of the programs. Despite the uncertainty around the benefit estimates, rigorous analytical methods showed that the value of the benefits exceeded the costs for the programs. Having realized from the beginning that the study results would be criticized whether they supported early childhood interventions or not, RAND recruited a panel of nationally recognized, clearly nonpartisan scientists to review the work. Subsequent analysis conducted by a Federal Reserve Bank and a Nobel Prize-winning economist were consistent with RAND's results. The RAND early childhood study quickly changed the nature of public discourse about government funding for intervention programs involving young children. RAND's findings continue to be supported by numerous follow-up studies and a growing evidence base in support of high-quality early childhood investments.



## NATION-BUILDING

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After wars end, allied nations must undertake military, political, humanitarian, and economic activities to forestall a renewal of conflict, but these activities do not always succeed. RAND has examined nation-building efforts from around the world to identify key principles for their success, potential obstacles to peace, and implications for current and future nation-building investment. In the mid-1990s, RAND developed a method to help authorities determine the force size needed for peacekeeping and subsequently examined eight cases of U.S. nation-building—Germany, Japan, Somalia, Haiti, Bosnia, Kosovo, Afghanistan, and Iraq—drawing lessons from what amounted to a very substantial body of evidence. It did the same for similar missions led by the United Nations and European states. RAND continued developing a methodology for analyzing the effects of nation-building efforts by identifying and measuring inputs (such as troop levels and money) and outcomes (such as casualty levels, security, and economic growth). With access to the archives of the Coalition Provisional Authority, RAND researchers produced a detailed history of the 2003–2004 occupation of Iraq, exploring the accomplishments, failures, and challenges associated with that endeavor. In another study, RAND examined 20 post–Cold War U.S., UN, and European military interventions, finding that most of these interventions had been followed by improved security, some degree of democratization, significant economic growth, and modest improvements in human development and government effectiveness. RAND researchers determined that the key criteria for success in achieving enduring peace were securing support from regional states and drawing former adversaries into nonviolent forms of competition for wealth and power. The findings suggest the importance of setting realistic expectations—neither expecting nation-building operations to quickly lift countries out of poverty and create liberal democracies nor being swayed by a negative stereotype of nation-building that does not recognize its signal achievements in many cases.



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## QUALITY OF CARE

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In a series of studies spanning more than four decades, RAND established the scientific basis for defining and measuring the quality of health care. It led the development of reliable measures of health status—arguably the most important development in the last 60 years of health services research. RAND’s key process and outcome measures for evaluating quality laid the foundation for tools currently used around the world to increase the value of health care dollars spent. For example, RAND’s concept of measuring specific aspects of quality over a broad spectrum of care was influential in the development of the UK’s primary care delivery system, which gives physicians financial incentives to provide quality care. RAND’s Quality of Care Assessment Tools, a comprehensive, clinically based quality assessment system for adults and children, were used to produce the first national report card on health care quality. And RAND’s Assessing Care of Vulnerable Elders measures have been used by researchers to show that individuals of all ages and in all sociodemographic groups in the United States receive about half of recommended care, on average. In 2000, an influential report from the Institute of Medicine highlighted this quality chasm as a crisis in U.S. health care. Since then, a growing number of physicians and hospitals are operating under pay-for-performance and, more recently, pay-for-value contracts in which providers are given financial incentives to provide care that meets cost and quality standards.

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## THE DATABASE OF TERRORIST INCIDENTS

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The first formal U.S. federal government body charged with fighting terrorism, the Cabinet Committee to Combat Terrorism, was created in 1972. It quickly contacted RAND for analytical support, and RAND analysts began developing a database—the first of its kind—known initially as the RAND Terrorism Chronology. The federal government imported RAND’s database in the 1980s and built on it from there. RAND continued to develop and use the original, along with a parallel compilation of detailed case studies, to describe terrorism empirically so that the phenomenon could be systematically analyzed. As the database evolved, it became an increasingly valuable tool for discerning trends in terrorist tactics and targeting and other developments. The database enabled RAND to inform government policymakers on how terrorists made decisions, managed their violent attacks, and manipulated fear; how they viewed hostage situations, bargaining options, and nuclear weapons; and what resources they were able to mobilize. To cite just a few examples, RAND analyses helped shape the first instructions to American officials going into high-risk posts. They also informed the design and construction of diplomatic facilities abroad and the formulation of nuclear security measures in the United States.

PRELIMINARY DESIGN OF AN  
**EXPERIMENTAL**  
WORLD-CIRCLING SPACESHIP

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## HERALDING THE SPACE AGE

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The first RAND report, *Preliminary Design of an Experimental World-Circling Spaceship*, was published in 1946, roughly two years before RAND became an independent, nonprofit organization. At that time, the idea of launching a satellite into outer space was the stuff of science fiction. The report contained a detailed engineering feasibility study for a proposed satellite, specifying propellants and a maximum desirable acceleration rate and making a case for multiple-stage rockets. It also outlined potential uses of such a craft—for communications, surveillance, weather observation—and speculated that, in the future, a satellite might guide missiles to targets. Beyond this, the report advocated a major space initiative for reasons both practical and symbolic. This widely read report had an incalculable impact on the U.S. Air Force and elsewhere, changing attitudes and promoting a serious consideration of space travel, thereby preparing the intellectual way for the concrete achievements in space over the next half century and beyond.



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## WINDSURFING

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In 1969, RAND aeronautical engineer James Drake took a brief vacation from his defense systems work to write a RAND document in which he described a new water-sport vehicle. Explaining the sport, Drake noted, “A different sailing skill is required, more akin to surfing and skiing—boredom is completely eliminated—and once wind-surfing is mastered, it gives a unique and heady blend of sporting thrills.” After many years of extracurricular mental toying, Drake had come up with a craft that was ridden in a standing position and steered by a handheld sail assembly. He successfully tested his invention along the coast a few miles south of Santa Monica, California, where he lived and worked at RAND. The sail was designed so that the driving and turning forces were sensed and controlled directly by the rider, with no rudder necessary, and the board “surfed” on swells even in the open ocean. RAND supported Drake’s writing and illustration of the document and published the result. In 1970, Drake was granted the very first windsurfing patent. The activity went on to become a major, worldwide sport, and Drake is heralded as “the father of windsurfing.”





## PRIVACY IN A COMPUTERIZED WORLD

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As personal data collected from individuals and stored in computer systems began to mount throughout the 1960s, and as social security numbers increasingly became the way individuals were identified in the United States, the rules for protecting the privacy of this information were largely nonexistent. In the early 1970s, the U.S. Secretary of Health, Education, and Welfare created the Advisory Committee on Automated Personal Data Systems, and one of RAND's senior computer experts, Willis Ware, was asked to chair it. The resulting report defined a code of fair information practices that provided the basis for personal-information privacy law and doctrine in the United States and Europe. This groundbreaking achievement provided the intellectual foundation for the Privacy Act of 1974 and an array of ensuing legislation. Ware went on to serve on the Privacy Protection Study Commission and to become the preeminent expert as privacy concerns expanded to include the private sector in the following decades.



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GATM  
MULTI-POINT  
AMC

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**DANGER**  
AIRCRAFT ON JACKS  
AUTHORIZED PERSONNEL  
KEEP OUT

## THE WORLD'S PREMIER AIR LOGISTICS SYSTEMS

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Since its inception, RAND has devised innovations in logistical analysis to keep U.S. Air Force weapons and equipment operating under continuously evolving demands. In the 1950s, RAND was developing better ways to forecast demand for spare parts. In the 1960s, it developed METRIC, a mathematical technique for determining optimal peacetime inventory levels that now forms the theoretical foundation for modern inventory calculations across military and industrial settings. RAND also developed two techniques—the Logistics Composite Model (LCOM) and the Support Availability Multi-System Operations Model (SAMSON)—to identify cost-effective mixes of maintenance personnel and other base-level maintenance resources to ensure adequate sortie generation levels. Its procedures for efficient and responsive intrabase maintenance operations, which exploited emerging computer and communications technologies, form the basis for today's operations. In the 1970s and 1980s, RAND developed Dyna-METRIC to evaluate how component support resource mixes and rear support systems would affect aircraft availability; it is still used to evaluate unit readiness and wartime spares assessments. TSAR, another RAND creation, was a theater-level simulation model to help bases continue operating while under attack. In the 1990s, RAND developed approaches for closely coupling logistics with operations to meet uncertainty and the threat (CLOUT). RAND used these approaches to adapt lean production practices from the commercial sector for an Air Force logistics initiative. In 2000, RAND put forth a vision for agile combat support that would allow the Air Force to match scarce worldwide logistics resources to operational needs, with a key recommendation to strategically preposition war reserve materiel around the world. Since 2010, RAND has developed the Combat Operations in Denied Environments (CODE) suite of models and tools, which can assess the costs and benefits of various options—including logistics—to make air bases more resilient under attack. All these advances are the result of a unique collaboration with the Air Force that has saved billions of dollars and vastly improved the agility, readiness, and resiliency of the force. This area of RAND research has made an incalculable difference in American defense.

PLANNING

BUDGETING

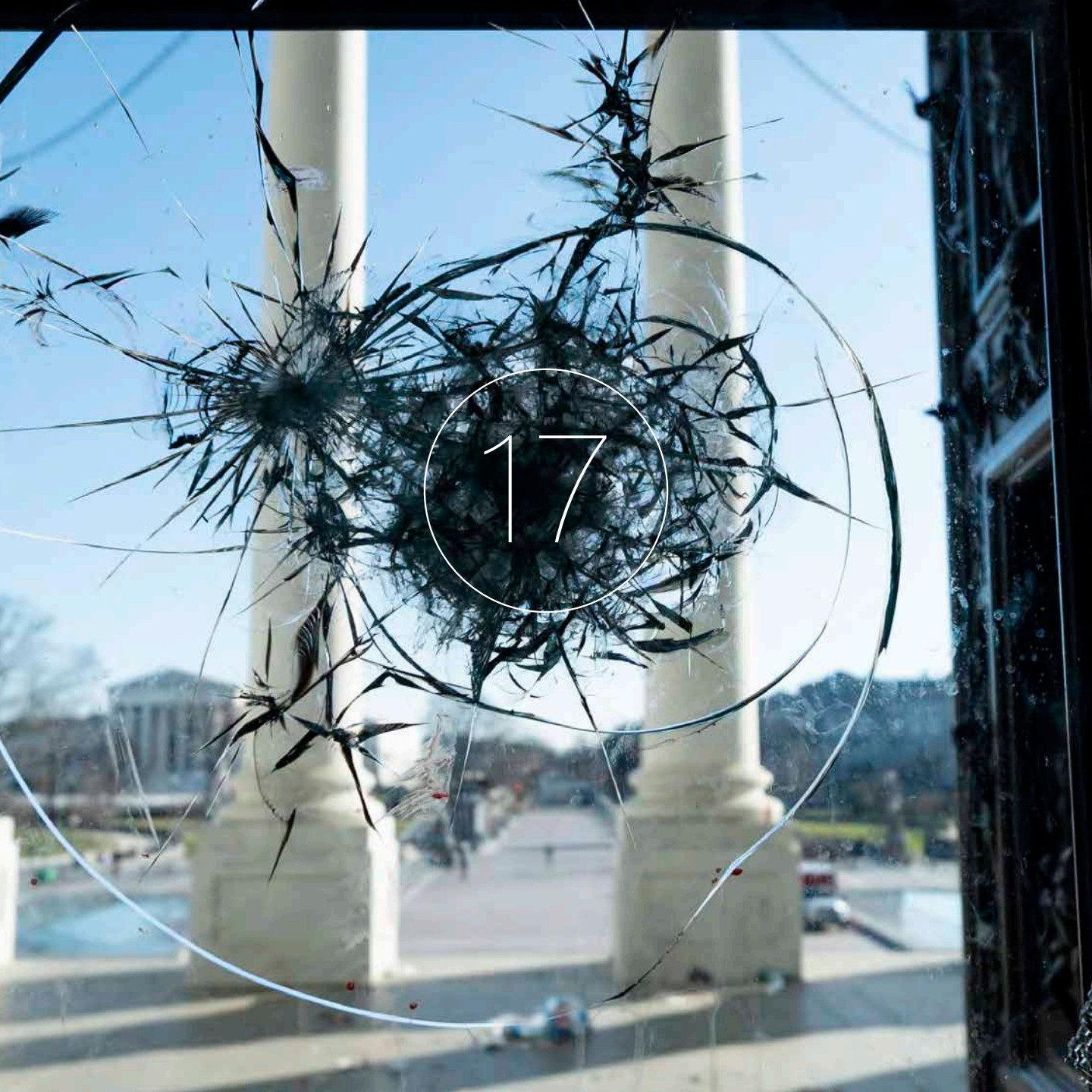
PROGRAMMING

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## THE PLANNING, PROGRAMMING, AND BUDGETING SYSTEM

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When Robert McNamara left Ford Motor Company to become the U.S. Secretary of Defense under President John F. Kennedy, he brought with him the belief that most national defense issues could be partly understood as a huge production system that could be rationally organized for optimal efficiency. That same year, RAND economists Charles Hitch and Roland McKean published *The Economics of Defense in the Nuclear Age*, which argued that, as RAND's work throughout the 1950s had shown, military problems were economic problems of efficient use of resources and could be better understood and addressed with the tools of economic analysis. McNamara embraced the intellectual concepts of the book, and Hitch became Assistant Secretary of Defense–Comptroller. Hitch proceeded to assist in creating the Planning, Programming, and Budgeting System (PPBS) based on the processes of analysis and budgeting outlined in the book and on earlier RAND work on governmental budgeting and accounting procedures led by David Novick. In the ensuing years, the PPBS approach spread to nonmilitary departments of the federal government as a means of centralizing, depoliticizing, and bringing rational analysis to policymaking and budgeting. Novick's book *Program Budgeting*, which extended the approach to nondefense arenas, became an overnight federal best-seller in 1965. Quantitative modeling and economic analysis have since routinely informed federal policymaking, and PPBS remains an important part of the structure that embodies this approach.



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## COUNTERING EXTREMISM

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In recent years, RAND has helped sharpen the U.S. government response to what top law enforcement officials described as the greatest domestic threat facing America: violent extremism. Working with the Department of Defense, the State Department, and the National Institute of Justice, researchers provided an unprecedented view of extremism online, in the military, and in society at large. They created a scorecard to help social media users avoid hateful and extremist content. The scorecard rates sites based on how receptive they are to such content. In that, it supported a key pillar of the nation's strategy to combat domestic extremism: making people more careful and skeptical of information they find online. Researchers also produced a network map of racially and ethnically motivated online extremist discourse and showed that the United States is overwhelmingly responsible for such harmful content. Separately, researchers developed a framework to help military commanders take more effective action against extremism in the ranks. The military prohibits service members from actively advocating for extremist activities. RAND's framework scaffolds that prohibition with actions commanders can take to detect, prevent, and address possible violations without infringing on service members' right to free speech. To better inform policy solutions, researchers also interviewed two dozen former White supremacists and Islamic extremists about what pulled them into extremism, and what pulled them out. Most had consumed extremist content through social media, books, and other propaganda that helped radicalize them, along with sophisticated person-to-person recruitment efforts by extremist groups. Confrontational interventions rarely worked. Instead, more than half said it was an encounter with someone they were taught to hate, who showed them unexpected kindness, that made them question their involvement in extremism. Researchers recommended a greater focus on media literacy, providing access to diverse sources of information, and fostering positive experiences with diversity as crucial steps to combat extremism. The government should also take a public-health approach, they wrote, identifying risk factors and investing in the long-term prevention of extremism.



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## SYSTEMS ANALYSIS

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The concept of systems analysis, which involves looking at a particular problem not in isolation but, rather, in the context of the whole system of which it is a part and then explicitly examining the consequences of alternative courses of action, was developed at RAND in the 1950s to address military challenges. The methodology's usefulness—particularly for analytic problems involving high degrees of uncertainty—led to its application in many other areas of policymaking. Systems analysis proved to be a transformative intellectual breakthrough that brought rational, quantitative assessment to bear on a vast range of complex problems. One of its first applications remains its most famous: RAND's early study of strategic basing options for the U.S. Air Force. The study set out to ask whether Air Force strategic assets could survive an attack and resulted in an entirely new approach to basing. America's strategic air bases were thereafter positioned primarily in the continental United States, not overseas, and the still-novel procedure of in-flight refueling became routine to give the strategic bomber force the range it needed. The study's results dramatically shifted American policy from a first-strike to a second-strike nuclear posture, which, in turn, led to a major reorientation of priorities, deployment plans, and procedures. The methodology was adopted across the field of military analysis, and its influence spread to nonmilitary realms. The capabilities for mathematical modeling of interrelated processes that lie at the heart of systems analysis have grown exponentially with the increasing power of the computer. So, too, has understanding of other dimensions of policy consequences. Today, systems analysis—in the evolved form of policy analysis—is prevalent in most major public and private policymaking arenas.

FREDERICK S. PEARSON  
RAND GRADUATE SCHOOL

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## A GRADUATE SCHOOL OF POLICY STUDIES

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**P**olicy analysis—the application of scientific methods to problems of public policy in domestic, national security, and international affairs—is still a relatively new academic discipline. In the late 1960s, RAND identified a need among U.S. federal, state, and local governments (and among international institutions as well) for the interdisciplinary skills of policy analysts. In 1970, realizing that it could provide an environment ideally suited to educating students in policy analysis because of the rich range of research opportunities and the teaching talent available among its research staff, RAND founded the RAND Graduate Institute. Today, the school is the world’s leading producer of Ph.D.’s in policy analysis, has the distinction of being the only policy school based at a policy research institute, and is helping redefine what public policy means at a time when policymakers no longer automatically turn to government to solve all problems but increasingly rely on partnerships among government, business, and civil society. Students from around the world learn the importance of methodological and analytic innovation and conduct hands-on, real-world policy research with RAND mentors as part of a curriculum that includes required and substantial on-the-job training. Close to 400 graduates have gone on to serve in leadership roles in private industry, government, think tanks, and academia in dozens of countries around the world. The school has been renamed twice: in 1987, as the RAND Graduate School, and in 2003, after a generous donation from RAND alumnus Frederick S. Pardee, as the Pardee RAND Graduate School.



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## EMAIL

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In an unusually pragmatic and helpful example of experimental computer science, RAND researchers in the early 1970s created an email system called MH (for Mail Handler) that could process large amounts of email with great efficiency, maintain it in perfect order, and archive it automatically. MH also had a special file for tracking its own and its users' activities. Deliberately integrated into the specific structure of the most advanced operating system, UNIX, MH required virtually no training for UNIX users. MH was never converted into a commercial product, but it was freely available and became the email system of choice on the Arpanet (eventually, the internet) for 15 years. The principles of MH's design and the evolution of its features influenced an entire generation of network R&D engineers, and aspects of the MH design are incorporated into contemporary email systems.

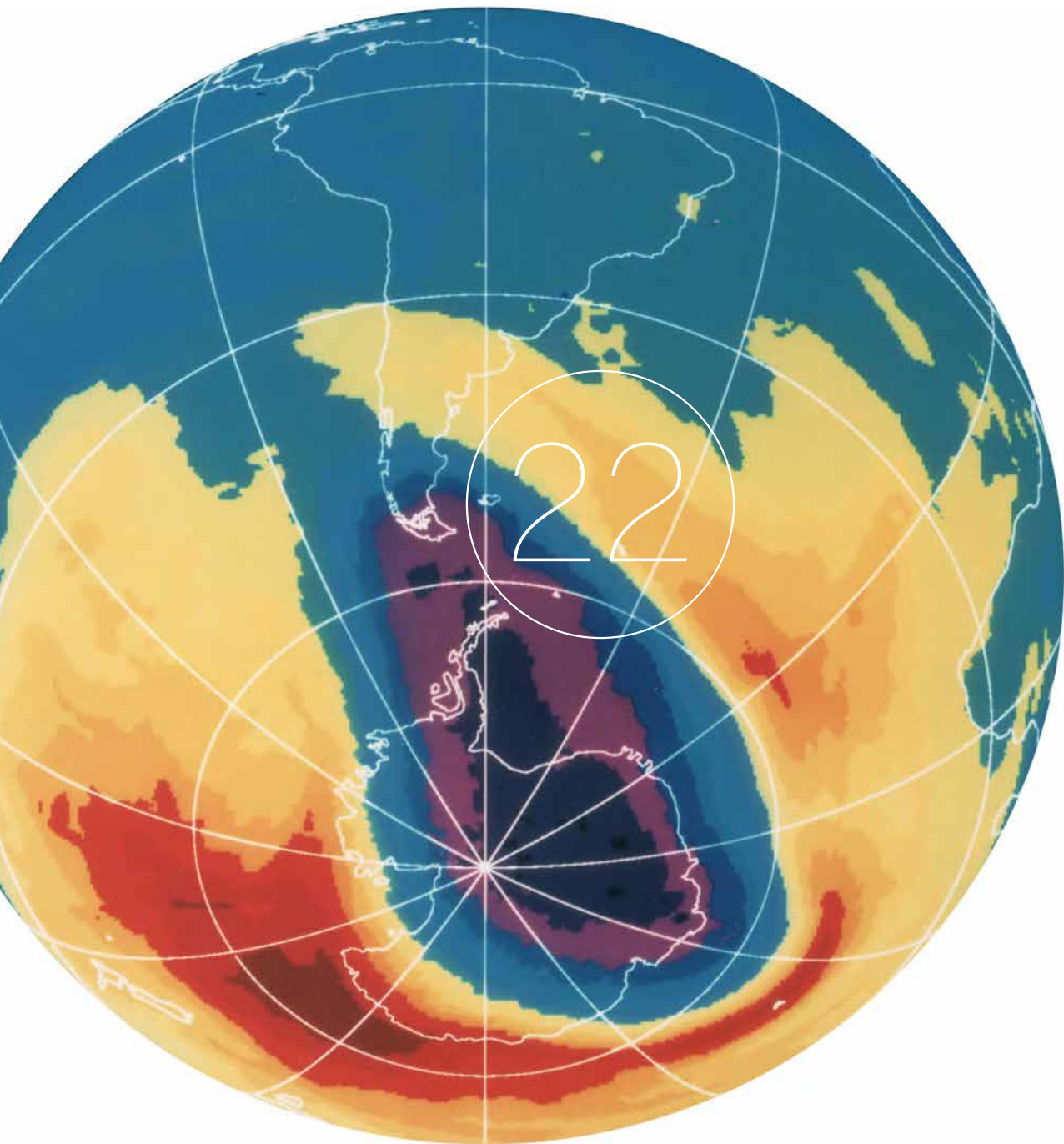


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## THE TREATY ON CONVENTIONAL ARMED FORCES IN EUROPE

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During the Cold War, the core security concern for the United States and NATO was a conventional forces conflict in Europe. The imbalance between NATO and Warsaw Pact forces in favor of the latter was considered the major potential source of instability and the most likely route to war. RAND mounted significant analytical efforts to find cost-effective ways to improve the balance. Major efforts to build up NATO forces were both politically and financially problematic, but arms control offered a way to accomplish much the same thing. Yet, by 1986, the Mutual and Balanced Force Reductions (MBFR) negotiations between NATO and the Warsaw Pact to reduce conventional forces in Europe were in their 38th round in 13 years—and the sides were making no headway. With new leadership in Moscow, the opportunity for a new approach was apparent. Using the same analytical tools that it used to assess force improvements, RAND found that, in conventional arms control in Central Europe, Warsaw Pact forces had to be reduced by at least 5:1 (relative to NATO reductions). It also showed that NATO became dangerously vulnerable if the ratio dropped below 4:1. The NATO proposal on the table in MBFR was around 3:1. RAND briefed this new set of ideas throughout Washington and Europe, to defense and foreign ministers, to NATO's Military Committee, and to others. The United States and NATO shortly thereafter entered into a new negotiation called the Treaty on Conventional Armed Forces in Europe, with a strategy influenced by RAND's analysis. Soviet President Mikhail Gorbachev, facing internal difficulties that would soon bring down the USSR, was eager to have conventional force reductions, and the treaty was signed in 1990.

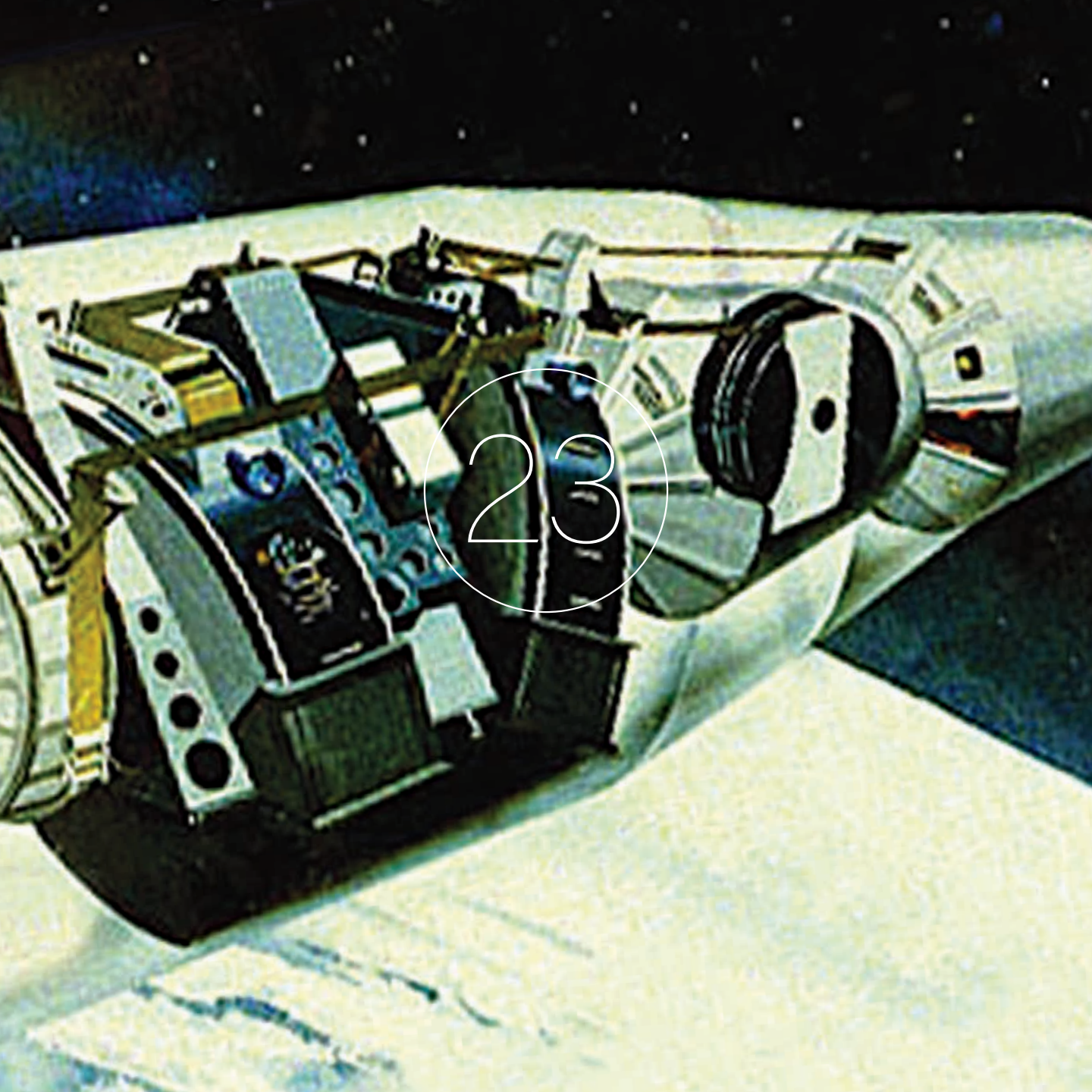




## THE OZONE LAYER

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In the 1970s, the scientific community raised concerns that commonly used chlorofluorocarbons (CFCs) were breaking down the earth's ozone layer. In an early phase of work for the U.S. Environmental Protection Agency (EPA), RAND studied the possibility of using a “marketable permit” approach to lowering nonaerosol CFC emissions. This was one of the first analytic evaluations of a strategy now broadly known as cap and trade. The actual effect of these chemicals on the atmosphere was not yet clear, and because they were being used to valuable effect in refrigerants, foams, and solvents, a total ban was not a policy consideration. In 1984, RAND began examining the level of emissions over the next 50+ years under various scenarios, in concert with a National Oceanic and Atmospheric Administration (NOAA) model of the atmosphere. This study predicted a very damaging effect on stratospheric ozone if current practices continued. At EPA's request, RAND researchers joined the U.S. State Department's diplomatic mission to the 1986 United Nations Environment Programme (UNEP) conference, where, largely on the power of the joint RAND-NOAA research, scientists arrived at a consensus that CFCs and a significant number of related chemicals were too dangerous to tolerate. In 1987, UNEP established the Montreal Protocol, which systematically phased out global production and consumption of the entire class of chemicals. Although there were still skeptics, RAND helped break the stalemate by framing the issue in a new way—based on probabilities, not certainty. In 1988, in a triumph of bipartisanship and a common set of facts, the U.S. Senate voted unanimously to approve ratification of the historic international agreement.



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## SPACE-BASED PHOTOGRAPHIC SURVEILLANCE

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The RAND Corporation was a central participant in the development of space surveillance capabilities. In the area of photographic surveillance, RAND's Project Feedback was a landmark engineering study that formed the basis for the early space reconnaissance program. Then, when the Soviet Union launched Sputnik in 1957, ahead of U.S. efforts, RAND researchers provided a proof-of-principle analysis of a satellite program that could quickly meet American space reconnaissance requirements. This study specified characteristics of the rocket, camera, and recovery aspects of the program that closely approximated what was ultimately realized in the actual system, particularly in the suggestion of a midair snatch of the deorbited surveillance material. RAND's approach was of major importance to what became known as the CORONA Project, in which a total of 121 satellites launched between 1960 and 1972 acquired approximately 800,000 images on 2.1 million feet of film and provided invaluable information during the Cold War, right up to the era of arms control verification. As a side benefit, RAND's proposal helped spur the development of videotape, a lighter and more durable medium for recording and storing images.



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## EARLY ACCOMPLISHMENTS IN ARTIFICIAL INTELLIGENCE

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When the first book ever published about artificial intelligence (AI) appeared in 1963, six of its 20 chapters had previously been published as RAND research reports. An extraordinary group of RAND researchers and consultants had developed some of the most influential early methods and tools for AI programming in such areas as problem solving, knowledge representation, and cognitive modeling. Many experts hoped for breakthroughs in AI that would allow computers to closely approximate sophisticated human thinking processes. In the development of “expert systems,” which were designed to capture the knowledge of specific spheres of expertise, RAND was at the forefront in demonstrating how—while not “thinking,” per se—computers could operate with a flexibility that mimicked certain mental functions and allowed the human user to interact more naturally with the computer. The AI concepts RAND developed were prominent among the early AI accomplishments that are deeply embedded in the basic architecture of technologies we take for granted today, from aviation traffic control to sorting mail by handwritten zip code.



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## COMPREHENSIVE SCHOOL REFORM

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When RAND was asked by New American Schools, a privately funded nonprofit exploring comprehensive school reform, to provide analytic support for its ambitious reform program, researchers welcomed the unusual opportunity to watch education reform dynamics unfold in real time from beginning to completion. The New American Schools endeavor represented the largest private investment ever made to stimulate reform in kindergarten through grade 12 (K–12) education. RAND had previously conducted groundbreaking research on the implementation challenges of federal school reform programs, spotlighting the collision of good federal intentions with the reality of implementing changes across many schools in varying local contexts. New American Schools was pursuing unified, integrated school designs that it hoped would create dramatic improvements in academic achievement. Its designs and implementation strategies were sophisticated in their assumptions about obstacles and complexities, and they were diverse in the concepts that underpinned each new school design. In providing analytic support for implementation and evaluating results, RAND was able to advance understanding of school reform, including the factors associated with strong and weak implementation. For example, school district policies were shown to be far more important than anticipated. In evaluating the extent of resulting academic achievement, RAND discovered that, although dramatically positive gains were not realized across the board, unified, “whole-school” change could indeed improve achievement when strongly supported by district policies. Overall, the New American Schools project produced vitally important lessons on how to carry out comprehensive school reform and linked it to academic improvement. Partly as a result of this research, the federal government adopted new strategies and funding for K–12 reform efforts.

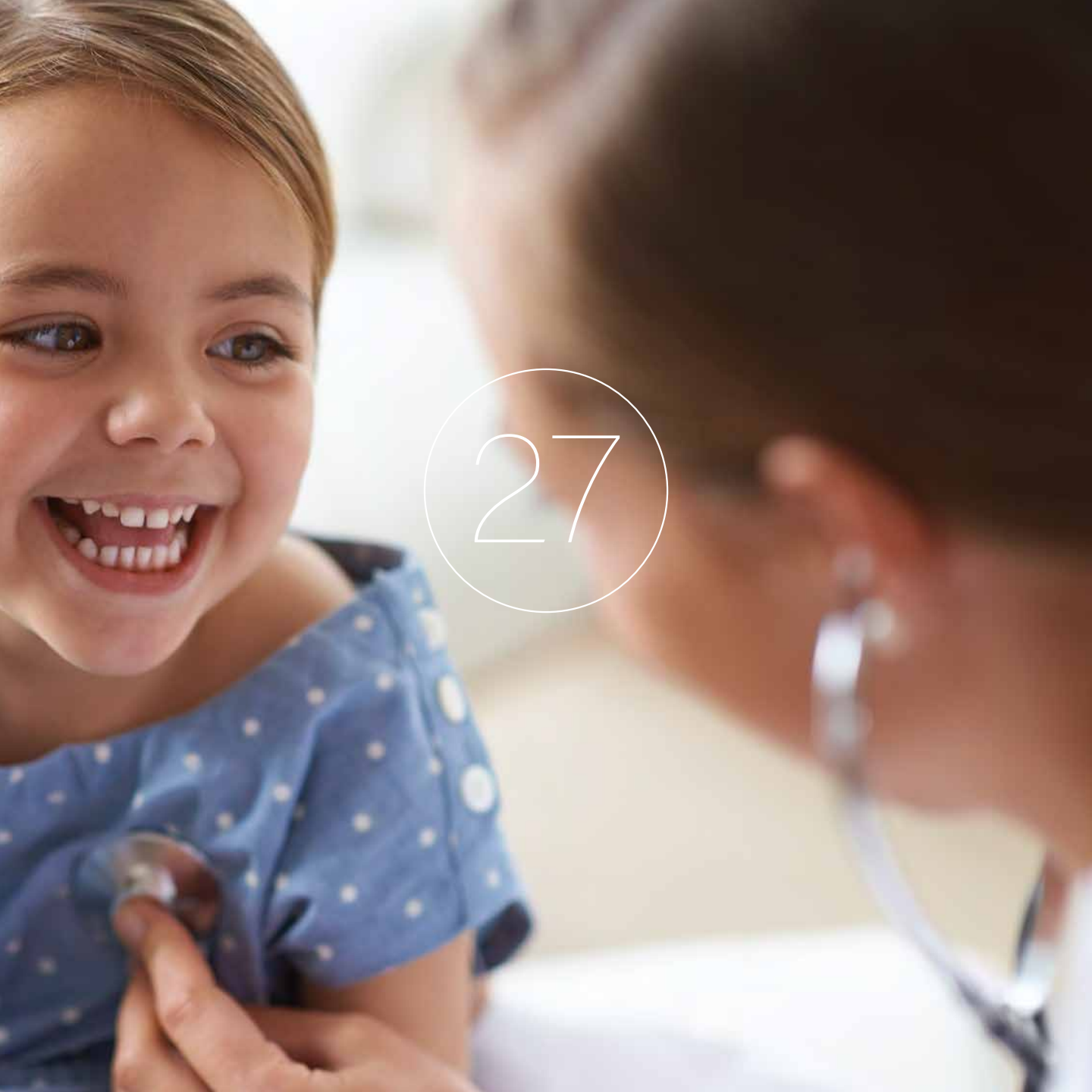




## NATO EXPANSION

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In 1991, as the dissolution of the Soviet Union appeared imminent, RAND studied the new challenges of European security. It concluded that extending NATO membership to several former Warsaw Pact nations would be advantageous to a stable future benefiting all nations, despite likely Russian opposition. Initially, the U.S. government was not inclined toward this thinking. But RAND's analysis began to find receptive audiences. The analytical insights bore fruit in the January 1994 decision by NATO's leaders to open the door to membership to former Eastern bloc members, and RAND's research underpinned and built support for the 1997 decision by NATO leaders to invite Poland, the Czech Republic, and Hungary to join the alliance. In 1997 and 1998, RAND analyzed issues and costs of NATO expansion and helped Hungary, Poland, and Romania assess and adapt their defense policies to become more effective allies. RAND researchers also organized early contacts between national security professionals in many of the soon-to-be-former Warsaw Pact countries and their NATO counterparts. In its overall effort to assess and demonstrate the value of NATO expansion, RAND's work was greeted as a trailblazing analysis in the Atlantic Community. Reflecting on RAND's first 50 years, Vaclav Havel, the first president of the newly independent Czech Republic, noted before leaving office, "More than any other such institution, RAND influenced the outcome of the Cold War. Looking toward the coming century's challenges, RAND's brilliance and independence will be more crucial than ever."



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## THE RAND HEALTH INSURANCE EXPERIMENT

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The RAND Health Insurance Experiment (HIE) is the only community-based experimental study of how cost-sharing arrangements affect people's use of health services, the quality of care they receive, and their health status. Performed in the 1970s and early 1980s, the HIE remains the largest health policy study in U.S. history. RAND recruited 2,750 families and randomly assigned them to one of several health insurance plans: a health maintenance organization and fee-for-service plans that varied patient cost sharing from none (all care is free) to 95 percent. Families participated for three to five years. The HIE demonstrated that the amount patients pay out of pocket for care influences how much care they use. The larger the cost sharing, the greater the reduction in use; however, cost sharing reduced highly effective and less effective services in roughly equal amounts. Individuals with free care used about one-third more care than patients with copayments, but they were no healthier. The link between patient payment and service use underlies many current health care arrangements. Drug plans use variable out-of-pocket costs to give patients incentives to use generic rather than brand-name drugs. Consumer-directed health plans combine a high deductible with a tax-advantaged personal health account, and monthly premiums are reduced. The plans save money because patients seek less care and use less-expensive care. The HIE provided an empirical framework for considering how patient cost sharing affects total health care costs, quality of care, and population health.

A close-up photograph of a person's eye looking through a metal grid. The eye is the central focus, with a bright reflection on the iris. The grid is made of dark, intersecting lines. The overall color palette is dominated by dark blues and greys, with a bright, circular highlight on the eye. A white circle is overlaid on the image, containing the number 28 in a simple, white, sans-serif font.

28

## “NETWAR”

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In 1993, RAND analysts identified an emerging form of societal conflict in which antagonists are organized in leaderless, sprawling networks rather than hierarchical structures. The phenomenon was of particular interest because it tended to blur the lines between peace and war, offense and defense, and combatant and noncombatant; RAND coined it “netwar.”

Whether for criminal, terrorist, ethno-nationalist, or other purposes, netwar antagonists take advantage of information technology to operate in a decentralized mode that renders them harder to detect and freer to take the offensive. RAND noted that many terrorists, criminals, fundamentalists, and ethno-nationalists were developing netwar capabilities and that, essentially, a new generation of revolutionaries and militant radicals was emerging with new doctrines, strategies, and technologies. The analysts also noted that the emergence of netwar raised the need to rethink strategy and doctrine to counter netwar. RAND has since clarified and elaborated on the concept of netwar as world events continued to present new evidence of its manifestations. After the attacks of September 11, 2001, RAND’s report summarizing research on netwar was in high demand, and the concept has rapidly expanded with the growth of the internet, social media, large-scale data hacks, and the dark web—with RAND again at the forefront of research efforts.



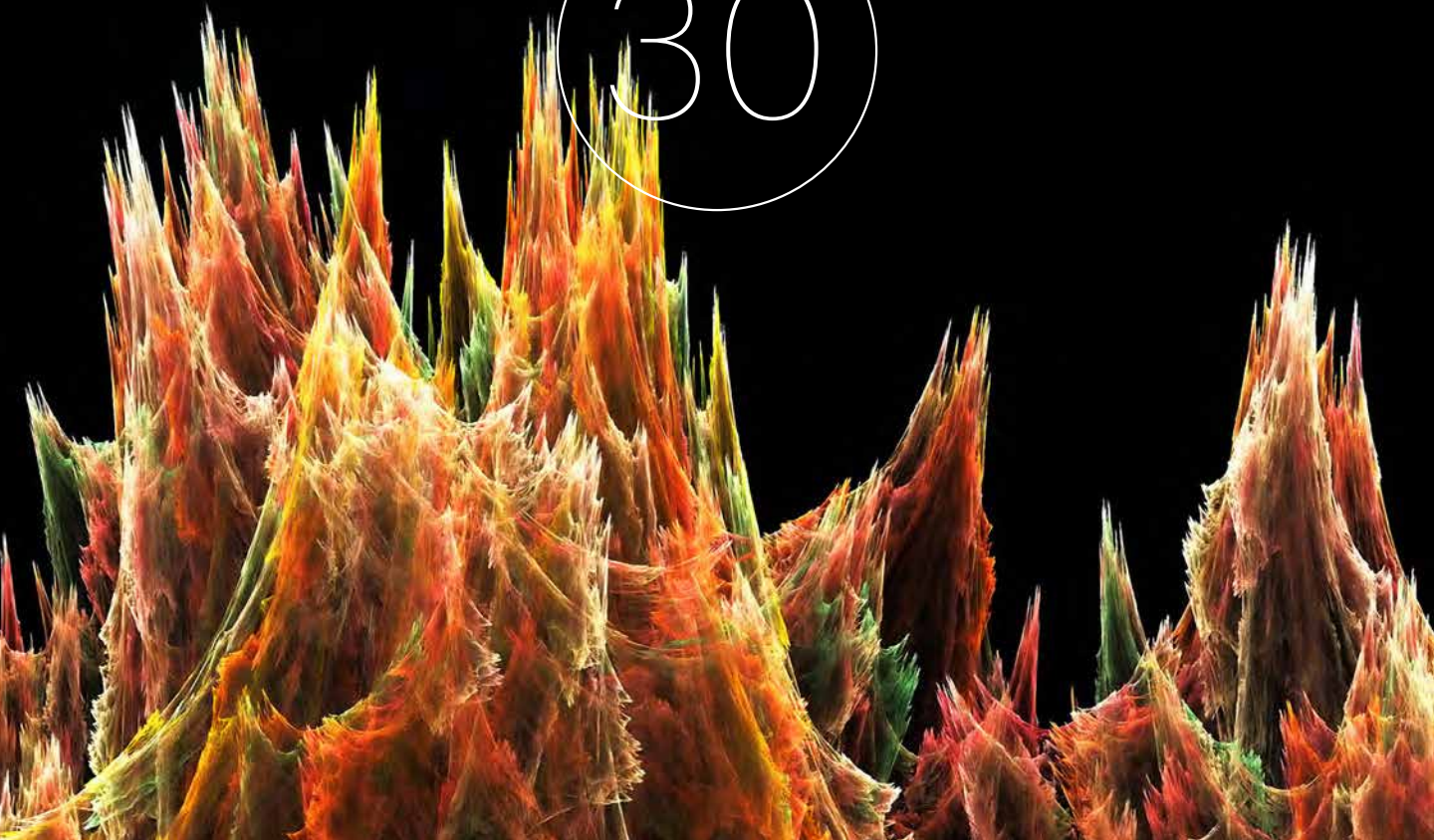
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## PRIVATE-SECTOR PRACTICES FOR PUBLIC-SECTOR PRIORITIES

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By the 1980s, a global revolution in commercial business practices had led to widespread and increasingly successful alignment of the activities that companies used to produce outputs with those companies' priorities. The federal government, watching these dynamics and eager to constrain the expansion of its institutions, looked to the private sector for guidance. This led to a formal initiative intended to reform and downsize government, improve performance, and lower costs. At about this time, RAND began building what would become a major and ongoing body of research to help the U.S. Department of Defense and other agencies adopt leaner practices and improve their management of private contractors for activities that were best outsourced. RAND assumed two roles in these efforts: (1) collecting information on best commercial practices and (2) adapting these practices to specific government environments to ensure success in these settings. In the former role, RAND surveyed large corporations that had ambitiously and successfully transformed their operations, learning what challenged these organizations, what solutions had proved effective, and what general principles could be drawn from their experience. In the latter capacity, RAND made recommendations on how to tailor changes to the federal government's financial and information management, budgeting, incentive, and labor management systems. RAND mapped value chains inside and outside the government and helped align each element in these chains to the sustained priorities of an agency's leadership. It subsequently analyzed logistics, facility and property management, environmental management, purchasing and supply management, and broader acquisition management issues for a wide variety of federal government sponsors. Because best commercial practices are ever evolving, new opportunities to learn from the private sector are ever present. RAND seeks to help government agencies stay engaged with best commercial practices and learn as these practices continue to improve over time.

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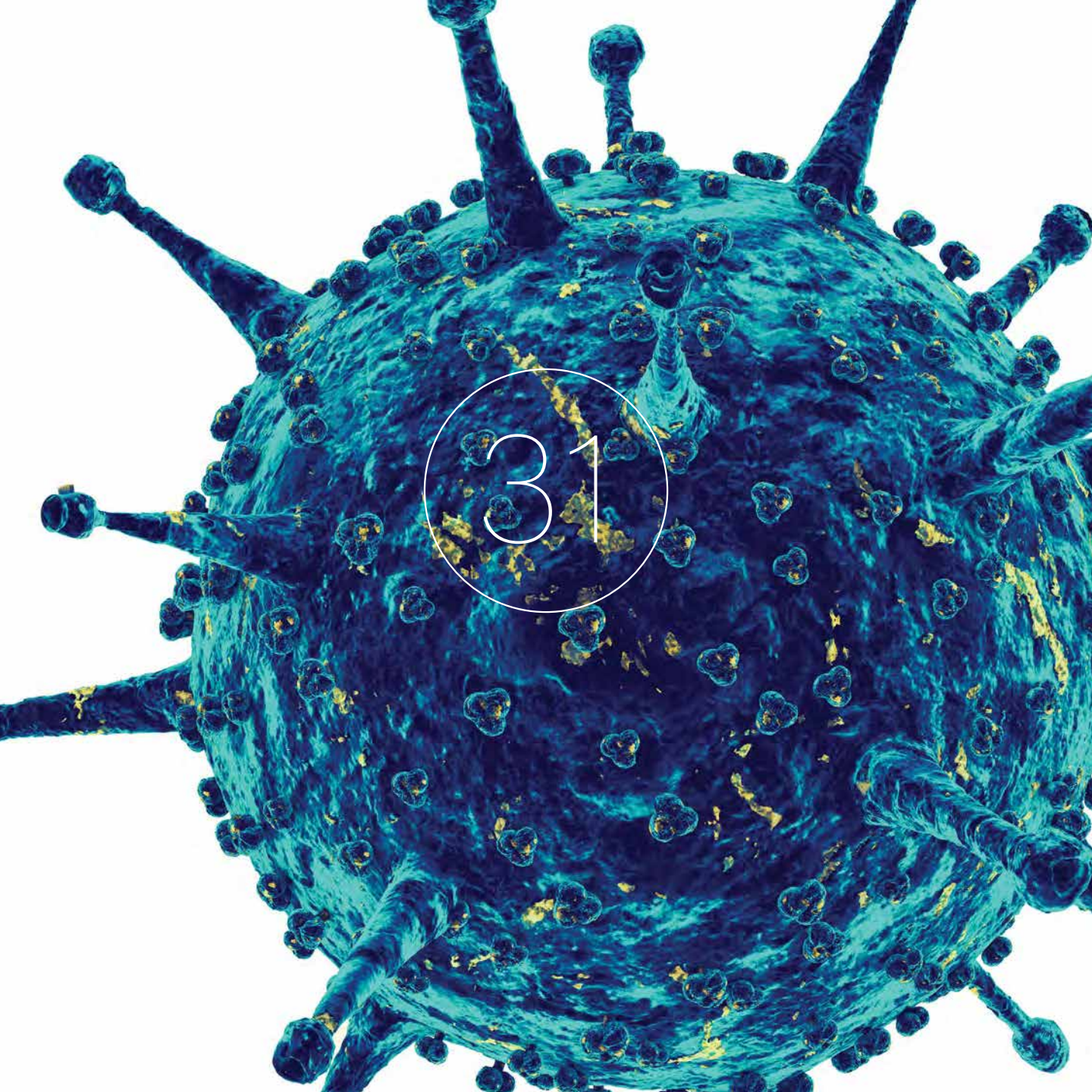




## ELECTROMAGNETIC PULSE

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During high-altitude nuclear weapon tests in the 1950s and 1960s, it was discovered that the interaction between radiation from a high-altitude nuclear explosion and the earth's atmosphere generated energetic electrons in the so-called "deposition region." These electrons spiraled in the earth's magnetic field, generating a short, widespread, and intense electromagnetic field called high-altitude electromagnetic pulse (HEMP), which radiated downward from the deposition region. Research at RAND and Los Alamos National Laboratory led to a theoretical understanding of the electromagnetic fields produced. RAND and others quickly noted the potential for damage to military and civilian communications and electronic systems, particularly because the vacuum-tube technology of the era was giving way to the much more vulnerable solid-state electronics of the future. Efforts to understand the HEMP threat focused on developing an electromagnetic pulse criterion that would accurately characterize the maximum threat level of an optimized nuclear weapon. Initial analyses by others led to a pulse criterion associated with major effects—requiring extensive hardening to protect sensitive electronic components from damage. In the early 1980s, RAND was asked to review this work and provide an independent assessment of the threat to military aircraft. RAND's research factored in practical considerations of weapon designs and developed new ways to assess the vulnerability of typical military aircraft electronic systems. This research led to a more reasonable estimate of the level of HEMP that could be produced by optimized nuclear devices and resulted in significant reductions in the degree of hardness—and thus in the amount of associated investment—required to prevent damage to sensitive electronic components.



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## HIV

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In the mid-1980s, the U.S. Centers for Disease Control and Prevention was tracking a mysterious disease that was spreading at an alarming rate. Ninety percent of those infected died, but public officials did not know how to respond. RAND used its own resources to model the disease, revealing its dynamics and transmissibility and underscoring the need for more-comprehensive research. The most influential work to emerge was the RAND-led HIV Cost and Services Utilization Study (HCSUS), the first major effort to collect information on a nationally representative sample of people in care for HIV in the contiguous United States. HCSUS provided essential information on the costs of care, barriers to access, and the effects of HIV on quality of life and ability to function. HCSUS engaged the HIV community at every stage of the work, changing the context in which such a study was typically designed and conducted and influencing how the findings were interpreted and communicated. More recent RAND work continues that legacy by exploring challenges that patients face in obtaining care for their conditions, including HIV, such as stigma, medical mistrust, and obstacles to treatment adherence. Today, HIV is considered a chronic infection that can be managed. Connecting HIV-positive individuals to treatment and motivating them to stay connected are public health priorities because treatment reduces the risk of transmitting the disease. RAND experts have explored innovative ways to promote treatment adherence, such as behavioral economics and social networks, focusing on at-risk populations both in the United States and abroad.



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## AIR BASE RESILIENCY

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For almost its entire history, RAND has helped the U.S. government understand how best to defend friendly air bases and attack adversary bases. Since its 1951 report *Time, Equipment, and Costs to Repair Cratered Runways*, RAND has published 200 reports identifying the most effective means to attack or defend runways, parked aircraft, and infrastructure. There was a brief hiatus in such research after the fall of the Soviet Union, but the rise of China and Russia as military threats has reinvigorated RAND research on this topic. Since 2011, RAND has examined how the military and its infrastructure might fare in a conflict with increasingly capable near-peer adversaries. RAND researchers have assessed the vulnerabilities of U.S. air bases in the European and Pacific theaters, the likely impact of an attack, and the U.S. ability to recover and maintain air operations. In a series of classified studies and conversations, RAND researchers have offered the U.S. government cost-effective options to reduce those vulnerabilities and protect personnel, aircraft, and facilities. The implications of this research and analysis prompted senior U.S. officials to invest millions in base resiliency capabilities. RAND researchers have also worked to improve the resilience of U.S. military bases worldwide to cyberattacks. Drawing from a wide range of disciplines, including mathematical graph theory and cyberphysical systems engineering, RAND pioneered a method for identifying critical systems and determining how cyberattacks might degrade vital Air Force missions. Similar lines of research have looked at the vulnerability of industrial control systems and electrical power generation equipment on installations and their potential effects on Air Force missions. RAND research for the Air Force Surgeon General has also recommended investments in medical facilities and changes to tactics and procedures to improve medical operations during emergencies.



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## LINEAR AND DYNAMIC PROGRAMMING FOR PROBLEM SOLVING

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Suppose it is 75 years ago and you want to find the optimal solution for a complex problem about which there are many unknowns, such as designing the least-expensive diet possible with a specific nutritional value from an assortment of foods whose nutrients and price you know. How do you figure that out? The answer is slowly—at least it was until the advent of linear programming. The word *programming* is used here in the sense of planning or allocation, not computing, and it applies to a system of linear equations. The great problem-solving potential of linear programming became more fully realized in the 1950s, when George Dantzig at RAND published his research memoranda on linear programming and the “simplex method” for solving problems. The simplex method provided an efficient approach to solving complex optimization problems that could not otherwise be solved by enumerating all possible solutions—even with computers. RAND research on optimization techniques extended beyond the simplex algorithm and contributed substantially not only to RAND’s own calculations but also to an extensive range of analyses across many disciplines. For example, expanding on the advances in linear programming, Richard Bellman at RAND created dynamic programming, which enlarged the universe of optimization problems that could be solved by exploiting certain problem structures. Linear and dynamic programming have since expanded into areas of analysis from industrial processes to management planning, influencing almost every complex business decision involving multiple objectives and constrained resources.

**CAUTION**



34



## IMMIGRATION

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In the mid-1980s, public debate over the increase in immigration from Mexico into the United States centered on fears that these immigrants took jobs away from Americans, placed a tax burden on citizens, and created barrios of Spanish-speaking people who did not become integrated into American life. To explore the evidence regarding these claims, RAND studied the economic effects of immigration from Mexico on California. On the basis of solid empirical analysis, the study found that, with the notable exception of educational services, Mexican immigrants contributed more to public revenues than they consumed in public services. The study further reported that these immigrants followed the classic pattern of integration into U.S. society, with the significant help of education. Twelve years later, RAND studied immigration again—this time, immigration from all countries—and concluded that the economic costs to California were beginning to outweigh the economic benefits. At about the same time, a senior RAND economist led the National Academy of Sciences panel on the New Americans in another study of immigration's probable impact over the next 50 years on demography, economics, and tax burden. The New Americans study concluded that immigration would have a major impact on the size and ethnic composition of the United States, and, while immigration would have a net positive economic impact, it would be small relative to the size of the national economy. The study also found that, although the fiscal impact would be positive for the nation, it would be negative for California—not because of immigrants' health care use, as widely believed, but because of the cost of their education. It is a measure of the study's actual and perceived fairness that it has been referred to by people on all sides of the immigration debate.



35

## COUNTERINSURGENCY

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For more than 60 years, RAND has analyzed and identified best practices for counterinsurgency. In 1962, RAND held the first worldwide symposium on counterinsurgency, bringing together experts in the field, including military personnel who had been involved in insurgency and counterinsurgency conflicts dating back to World War II. One of the participants was David Galula, the former French officer whose book *Pacification in Algeria*—written while he was at RAND—is now considered a classic in the field. RAND’s counterinsurgency research expanded during the Vietnam War, with its motivational studies of the Viet Cong, and again during the Central American insurgencies of the 1980s. RAND researchers developed an increasingly thorough, history-based understanding of the characteristics of insurgency and formulated a workable approach to counterinsurgency. RAND was centrally involved in the development of strategies for dealing with populations during insurgencies—recommending actions to gain popular support on the one hand and a combination of incentives and disincentives on the other. RAND also identified tactics now considered crucial to counterinsurgency operations, such as border control and pacification. More recently, RAND played a critical role in analyzing the insurgencies in Iraq and Afghanistan, where its researchers spent considerable time on the ground. This work examined such issues as the competence of local police and outside support, as well as their effect on the success or failure of past counterinsurgency operations. RAND’s work continues to be widely read at senior levels of government in the United States and allied countries.



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## SAVING THE GOVERNMENT MONEY

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The RAND classic *Military Research and Development Policies* was published in 1958, and over the decades since, RAND has been seeking ways to help build sound business principles into the U.S. process for acquiring military weapon systems. The basic goals of this ongoing endeavor are to gain greater value for dollars spent, streamline systems, and maximize opportunities for competition and innovation in advanced weapon acquisition. Because of the enormous complexity and cost, extremely long development phases, and the importance of innovation in military systems, RAND has conducted a steady stream of empirically based studies on acquisition over the decades. For example, RAND pioneered the development of parametric cost-estimating relationships that could be used to calculate the cost of a system and to explore alternative concepts and strategies. In the past 30 years, RAND analyses have produced detailed, practical recommendations related to procurement strategy, scheduling, testing, cost analysis, industrial base analysis, alternatives, and other aspects of acquisition for fixed-wing aircraft, submarines, aircraft carriers, surface ships, missiles, engine and avionics subsystems, and information systems. Most recently, RAND assessed the cost savings of block buys of the F-35—the largest weapon system program in U.S. history. RAND’s recommendations adopted by the U.S. military and many allies over the years have resulted in savings of billions of dollars and helped ensure continued innovation and quality in an industry with fewer and fewer providers.

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## RANDOM NUMBERS

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It may not sound like an enormous accomplishment, but in truth, RAND's 1955 publication of *A Million Random Digits with 100,000 Normal Deviates* has made a significant difference ever since it was compiled. The volume offered what was, at the time, the world's largest source of random numbers. RAND's own analysts needed truly random numbers for their many modeling studies, but the supply of numbers they produced also proved essential to statisticians, physicists, pollsters, lottery administrators, quality-control engineers, and even, lore has it, submarine captains who needed to route evasion courses. In developing this resource—just one of many painstaking efforts that characterized the organization's pioneering work in computing—RAND built its own special electronic mechanism to produce the numbers and then tested them to weed out any accidental patterns. *A Million Random Digits with 100,000 Normal Deviates* has been reprinted many times over the decades and is now available online.



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## TRAUMA AMONG CHILDREN

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More than half of U.S. children have suffered adverse experiences, including community and school violence, physical abuse, neglect, and natural disasters. These children face heightened risks of post-traumatic stress, depression, behavioral problems, and school failure. Schools offer a promising site for helping these children because school-based treatment can reduce barriers to mental health care. RAND researchers collaborated with the Los Angeles Unified School District and the University of California, Los Angeles, to develop the Cognitive Behavioral Intervention for Trauma in Schools (CBITS), a program designed for mental health professionals to deliver in a school setting. CBITS is intended to reduce symptoms of post-traumatic stress disorder, depression, and behavioral problems and to improve functioning, grades, and attendance; peer and parent support; and coping skills. Multiple evaluations have showed that CBITS works and is well accepted by students, parents, and teachers. CBITS is recognized as a recommended practice by the Centers for Disease Control and Prevention's Prevention Research Center, the Substance Abuse and Mental Health Services Administration's National Registry of Evidence-Based Programs and Practices, and the U.S. Department of Justice's Office of Juvenile Justice and Delinquency Prevention. CBITS has become an important public health tool, helping to build resilience in communities. For example, it was used extensively after Hurricane Katrina. Now individuals trained in New Orleans are training others in Houston. Every year since the 2012 tragedy at Sandy Hook Elementary School, CBITS team members have gone to Newtown to train all school mental health clinicians in how to use the intervention to identify children still traumatized by the mass shooting. A free website with more than 18,500 registrants provides support for implementing CBITS and training for mental health professionals unable to attend training in person. A version of CBITS, known as *Support for Students Exposed to Trauma*, has been adapted for delivery by regular school staff with no mental health training. Bounce Back is a CBITS adaptation for preschool children.



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## ALTERNATIVE DISPUTE RESOLUTION

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In the early 1980s, the RAND Institute for Civil Justice began studying two increasingly popular alternatives to trials: arbitration and mediation. Over the next 20 years, RAND was one of the leading U.S. sources of research on this topic and was able to produce statistically valid conclusions about these alternative dispute resolution (ADR) methods. The research revealed, contrary to general perception, that neither mediation (a conciliatory strategy that is nonbinding) nor arbitration (a streamlined trial-like process with a decision rendered by a third-party neutral) necessarily reduced the cost of litigation or the speed to resolution. Nevertheless, ADR programs did have important effects. Parties on both sides of cases subject to mediation and arbitration felt that they were treated more fairly than in traditional litigation and were more satisfied with the overall process. The results from these RAND studies were cited across the United States as individual court systems debated the pros and cons of adopting ADR programs. Ultimately, these findings served to provide courts interested in exploring these alternatives with more realistic expectations about what they could accomplish.



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## GAME THEORY

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Many people mark the beginning of the mathematical field of game theory with the 1944 book *Theory of Games and Economic Behavior* by John von Neumann and Oskar Morgenstern. Von Neumann was later a consultant at RAND. RAND's mathematics department, taking his work as a point of departure, excelled in game theory, particularly the aspect of the field that involved non-zero-sum games. RAND analysts contributed numerous advances to the field of game theory. RAND mathematician and eventual Nobel Prize winner Lloyd Shapley, who lent his name to the concept of the Shapley value, contributed major insights into game behavior involving three or more players in actual social situations, such as voting. When a young Columbia economics Ph.D. candidate named Kenneth J. Arrow spent the summer of 1948 at RAND working on game theory, he had a conversation that led to the topic of his dissertation, which he finished writing at RAND the following summer. Issued as a RAND report, *Social Choice and Individual Values* describes the Impossibility Theorem for Social Choices and became the essential text for social scientists interested in applying sophisticated analytical mathematics to socioeconomic problems. When Arrow later won the Nobel Prize in Economics for his work, this book was cited as a major accomplishment and a turning point in the development of modern economics. Another Nobel Prize winner, Thomas Schelling, worked at RAND on problems involving analyses of how individuals, countries, and businesses make decisions while anticipating the likely responses of others. Merrill Flood and Melvin Dresher famously framed "the Prisoner's Dilemma" at RAND in 1950. And while at RAND, David Blackwell defined the "silent duel" situation in game theory. These advances and others helped advance game theory as a useful tool for examining strategic situations in many fields.

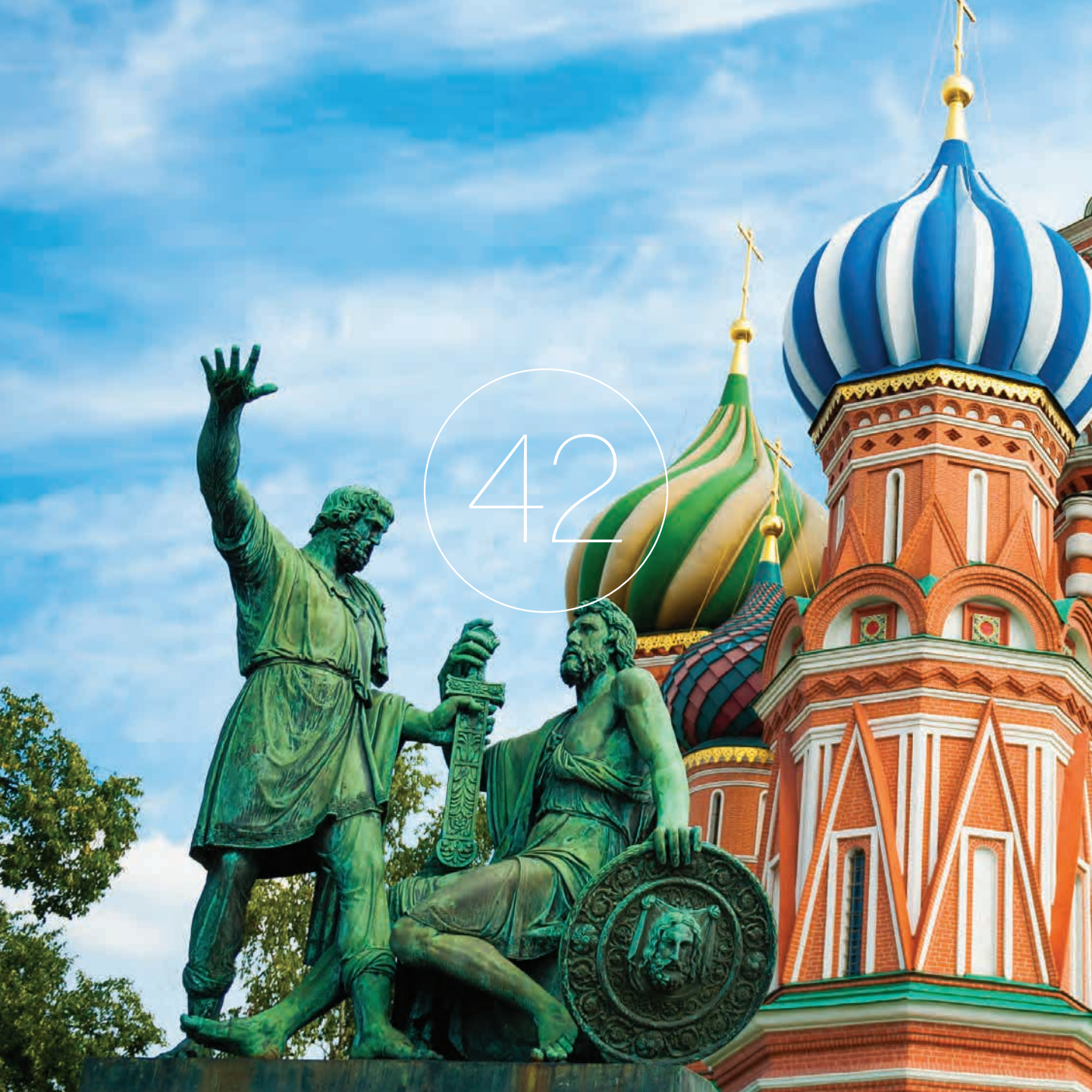


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## INVISIBLE WOUNDS OF WAR

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Those who serve in the military and apply for a security clearance to advance in their careers have long been required to disclose whether they have sought psychological counseling. Many service members, knowing about this question on the application, have avoided seeking care for psychological and cognitive difficulties resulting from their service. In mid-2008, the U.S. Secretary of Defense decided to change the wording of the question to encourage care and obviate stigmatization. This came about as the result of a body of research to which RAND contributed and from which RAND work stands out for its analytical scope and soundness. RAND's study, *Invisible Wounds of War*, galvanized attention to the policy debate. From 2007 to 2008, RAND conducted a national survey of veterans who had served in Iraq and Afghanistan and concluded that about one in five suffered from post-traumatic stress disorder or major depression. The study also found that approximately 19.5 percent of the service members may have experienced a traumatic brain injury during deployment. The study estimated that service members' post-traumatic stress disorder and depression alone could cost the United States more than \$6 billion (in 2007 dollars) in the two years after deployment. RAND examined the problem not merely as a U.S. Department of Defense or Veterans Health Administration concern but as a broad national issue that called for a major effort to increase the quality and availability of mental health care in military, veteran, and civilian health care systems. RAND's emphasis on reducing the barriers to seeking care has already, with other existing research, contributed to the change in security clearance questionnaires. RAND's unique emphasis on taking a broader approach has also affected the agenda of the U.S. Department of Health and Human Services and its National Institute of Mental Health. RAND's study remains one of the most cited sources of statistics on the mental health of the post-9/11 veteran population, the economic costs of post-traumatic stress disorder and depression, and gaps in the nation's ability to address the psychological support needs of those who have served.



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## SOVIET STUDIES

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The RAND Corporation's first years coincided with unnerving developments in the Soviet Union—a massive, hostile, and largely unknown opponent. The most alarming of these was the Soviet Union's test of its first atomic bomb far ahead of any predicted timeline. RAND began a far-reaching social-scientific analysis of the Soviet Union to help shed light on the motivations of its communist government, the mentality of its leaders, the nature of its military strategy and doctrine, and the structure and dynamics of its economy. The interpretation of data under these high-stakes circumstances would have been challenging enough, but information was so scant that RAND had to develop new methodologies to approximate specific areas of output in the Soviet Union's centralized economy. RAND analysts also had to apply new analytic approaches, such as “quantitative semantics,” to illuminate the Soviet mindset. The result was a pioneering area of study that produced a vast amount of knowledge and perspective, much of it published in books that remain classics of the era: *The Operational Code of the Politburo* (1951), *The Rise of Khrushchev* (1958), *War and the Soviet Union: Nuclear Weapons and the Revolution in Soviet Military and Political Thinking* (1959), *The Real National Income of Soviet Russia Since 1928* (1961), and *The Soviet Political Mind* (1963). The information and insight generated at RAND informed and influenced policymaking within the U.S. Departments of Defense and State and within the Central Intelligence Agency. Throughout the 1970s and 1980s, RAND continued to study the implications of Soviet developments, providing valuable counterpoints to other, unrealistic assessments of Soviet capabilities. For example, *The Costs of the Soviet Empire*, an early 1980s RAND report, estimated the total economic costs of the acquisition, maintenance, and expansion of the Soviet empire, and another analysis was among the first to project the rise of Boris Yeltsin as a rival to Mikhail Gorbachev.



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## SURVEYS IN THE DEVELOPING WORLD

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Demographic research—the study of trends and patterns in fertility, migration, health, and related issues—has the potential to yield important information about countries and circumstances that directly affect U.S. strategic and commercial interests. This kind of research also helps allocate U.S. foreign aid. RAND has carried out family life studies and other demographic investigations since the 1970s, devising state-of-the-art survey methods to collect a wealth of data that scholars and analysts from various disciplines have found invaluable. For example, researchers conducting surveys in Bangladesh amassed data that have improved understanding of the effectiveness of immunization and family planning. That program also helped develop a better treatment for a particular diarrheal disease that had killed a million children a year. RAND researchers have worked effectively in Guatemala and Malaysia as well and have gathered particularly crucial data in Indonesia. An oil-rich nation with the fourth largest population in the world (and the largest Muslim population), Indonesia has been viewed as a key to Southeast Asian stability. Indonesia experienced an extended period of profound political and economic change over the past several decades, the implications of which are central to understanding the global economy. RAND was conducting its Indonesia Family Life Survey when the Asian financial crisis hit in the late 1990s, crippling Indonesia's booming economy. Data collected through the survey helped illuminate the effects of this economic turmoil on Indonesians and were used by decisionmakers to design policies and deliver assistance. RAND Family Life Surveys have been vital to economists whose models depend on high-quality data, and RAND has steadily pushed the envelope in terms of how much history and information its survey techniques yield.



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## SUMMER LEARNING

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The RAND Corporation has conducted the most comprehensive research on summer learning to date, demonstrating that well-designed summer learning programs benefit elementary students from low-income families in urban areas in math and reading and in social and emotional competencies. In 2010, The Wallace Foundation commissioned RAND to launch the National Summer Learning Project (NSLP), a six-year study and the first-ever assessment of large-scale, voluntary, district-run summer learning programs serving low-income elementary students. Research indicates that low- and high-income students have different rates of summer learning, likely contributing to the achievement gap between these two groups. However, the right summer learning programs can help low-income children close that gap. RAND research is helping leaders make decisions about how to design and implement these programs effectively. After the first summer of a randomized controlled experiment, RAND found that students who were selected to participate in the summer program in five cities entered school in the fall with stronger mathematics skills than those who were not selected to participate. After the second summer of the program, students with high summer attendance rates benefited in mathematics, reading, and social and emotional outcomes. As a result of the findings, stakeholders in Boston worked with the mayor's office and Massachusetts state legislature to increase access to high-quality summer learning opportunities that met the NSLP criteria. Although state-level legislation did not pass, Boston's mayor challenged the city to enroll 10,000 youth in summer programs, and community filled more than 12,000 slots.



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## INNOVATIONS IN MILITARY RETENTION

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The investment in selecting and training military officers is large, and the willingness of officers to remain in the military is affected by many factors, including pay, deployments, advancement opportunities, family circumstances, job opportunities outside the military, and individual preferences regarding military service. To understand the relationship between possible policy changes and retention, the military needed a model capable of encompassing all these factors. In pathbreaking research in the 1950s, RAND developed a dynamic programming model of military retention. In the late 1970s and early 1980s, RAND researchers were the first to apply stochastic dynamic programming (dynamic programming involving random elements) to military stay-versus-leave decisions. The research not only promoted a unified theoretical understanding of these decisions but also produced the first empirical estimates of a dynamic retention model. The model has since been extended to provide insight into theories of military compensation, federal civilian retirement systems, the enlistment and retention of military information technology personnel, and the analysis of proposed changes in military compensation and personnel management. RAND researchers extended the model to include reserve personnel and analyzed military compensation reform proposals under consideration by the 10th Quadrennial Review of Military Compensation. Most recently, they have used dynamic programming to examine how U.S. Department of Defense policy affects civilian employees, as well as the best options for retaining military pilots with the demand for pilots in the civilian sector growing. Today, economic applications of dynamic programming are at the core of advanced financial analysis and derivatives; industrial organization models of market entry, exit, and size; models of patent races; and models of incentives and retention within large commercial organizations.



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## SEXUAL ORIENTATION IN THE MILITARY

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At the request of the U.S. Secretary of Defense, RAND analyzed the possible effect of an end to the ban on the service of gay, lesbian, and bisexual military personnel. RAND's study determined that a policy ending discrimination based on sexual orientation could be implemented in a practical and realistic manner and suggested how. In the political climate of 1993, U.S. President Bill Clinton's campaign pledge to end the ban became infeasible, and a compromise policy of "Don't Ask, Don't Tell" was adopted. In 2010, at the request of the U.S. Senate Armed Services Committee, Secretary of Defense Robert Gates asked RAND to update the report to inform a Pentagon working group reviewing potential repeal of Don't Ask, Don't Tell. RAND researchers met with leaders from seven allied militaries; visited domestic law enforcement organizations, federal agencies, private corporations, and universities; held focus groups with service members; conducted a confidential online survey of gay, lesbian, and bisexual service members; tracked changes in public attitudes; and updated the conclusions of RAND's 1993 report. They determined that a policy permitting people who identified as gay, lesbian, or bisexual to serve openly would not diminish readiness and cohesion or be costly or impractical to implement. Consistent with RAND's conclusion, the Pentagon working group recommended the repeal of Don't Ask, Don't Tell and incorporated much of RAND's material into its own report. The repeal act was signed into law and, the following year, Don't Ask, Don't Tell was no longer official policy. This work, stretching over nearly a decade, is a striking example of how RAND's analytic rigor and nonpartisan perspective can enrich policy discussions in a very sensitive environment.



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## MULTIDISCIPLINARY GAMING

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Wargames have a history stretching back hundreds of years, and by the middle of the 20th century, the militaries of almost every nation used them. RAND was a pioneer in political-military wargames that brought together military analysts, economists, political scientists, mathematicians, military officers, and policymakers. Some of RAND's early gaming extended over days, weeks, or even months and involved the innovative and effective use of computers. Gaming generated ideas and insights, some quite contrary to incoming assumptions, leading to subsequent in-depth analysis to assess and refine these ideas. "Operational gaming" proved very useful in analyses of air defense, missile defense, military strategy, arms control, and logistics. Sometimes, insights from gaming were disregarded, as when they suggested that North Vietnamese would infiltrate through Laos if North and South Vietnam were separated by a well-defended demilitarized zone. Other times, they helped bring about changes in planning and operations, as when the Air Force broadened its concept of "centers of gravity" to include Saddam Hussein's Republican Guard in the 1991 Gulf War. Early RAND work with gaming and scenario-based analysis stimulated other organizations to embrace similar methods. In the 1980s, RAND pioneered "analytic war gaming" with global simulations that could escalate from localized crisis through stages up to general nuclear war or terminate along the way. Key political and military decisions could be made by human players, artificial intelligence computer models (agents), or a combination. This work led to numerous subsequent contributions to deterrence-and-influence theory. Since the 1990s, RAND's Day After exercises have helped sensitize policymakers and government agencies to the potential for crises of different types (e.g., nuclear use in the developing world and cyberwar) and helped them begin in earnest to find ways to head off or mitigate problems. Most recently, tabletop games developed and run by RAND researchers helped policymakers understand how vulnerable the Baltic States are to threats from a resurgent Russia and what can be done to address that vulnerability. RAND has also used gaming effectively in nonmilitary contexts. In one example, new perspectives on drug policy emerged when RAND conducted gaming exercises with law enforcement officials, policymakers, and public health professionals from around the world.

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## WORKERS' COMPENSATION

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**B**efore 2004, the California workers' compensation system was flawed in how it rated the severity of a disability, which then determined the benefits paid to injured workers. RAND had become aware of some of the system's disparities during earlier research into how well workers' compensation programs actually compensated workers for lost earnings due to injury. RAND had developed a straightforward model based on extensive data and demonstrated that the earning power of an injured worker fell far below that of an uninjured worker who previously had the same salary at the same workplace; that study spurred an increase in benefits to mitigate the discrepancy. RAND was later asked to use this approach to examine the fairness of the injury rating system. Here, RAND found arbitrary discrepancies among different categories of injury. For example, workers received higher compensation for knee injuries than for shoulder injuries, even when the two types of workers had similar lost wages. RAND actively participated in discussions of how legislation could make the rating system more rational and transparent, and RAND's data on diminished future earning capacity were cited in the law that created California's new rating system. RAND's recommendation for a two-tiered permanent disability benefit was also adopted, allowing greater compensation for workers who did not receive an offer of reemployment from their employer.

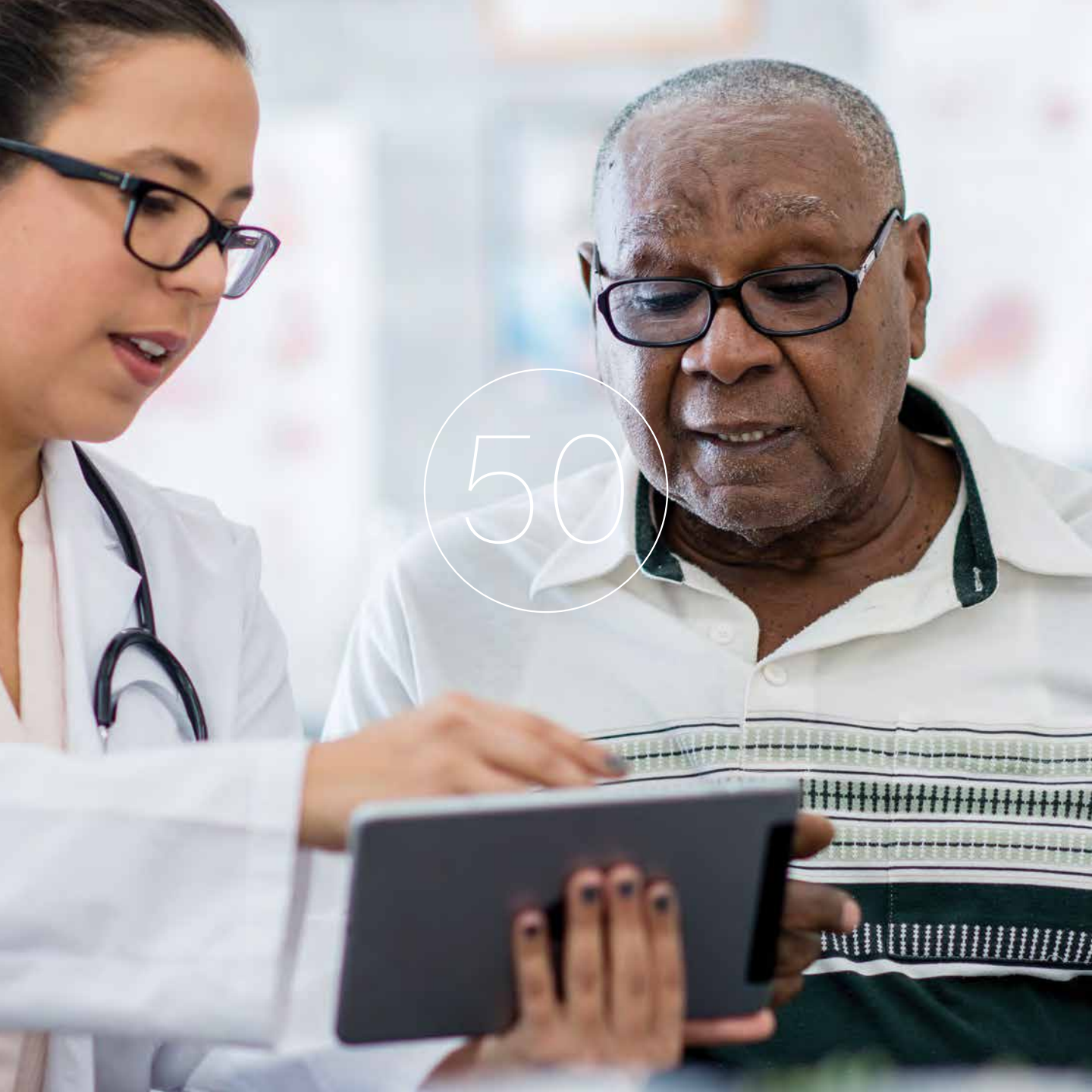


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## TRANSFORMATIONS IN ARMY LOGISTICS

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With increasing global competition and the “lean” revolution, U.S. private industry began adopting business practices that emphasized making processes as responsive, flexible, and efficient as possible. Recognizing the dramatic process gains the U.S. Army could realize if it employed similar practices tailored to the unique demands of warfighting, RAND developed an improvement approach known as velocity management. By analyzing large amounts of data on the demand, supply, and transportation of repair parts plus all the other items that support Army units, researchers determined exactly how well processes were working in the vast military logistics system. They analyzed inventory management, order fulfillment, financial management, and other processes to diagnose the sources of problems, recommend ways to streamline performance, and reduce the risk of disruptions. As the Army and its U.S. Department of Defense partners implemented the recommendations at installations, camps, and posts, they systematically transformed logistics practices everywhere that Army troops were stationed and deployed. In addition to accelerating processes, velocity management created opportunities for cutting costs: The traditional thinking—which held that more speed would cost more money—was upended, and a fast, reliable, cost-conscious logistics system emerged. A comparison of Army logistics in Operation Desert Storm (pre-velocity management) and Operation Iraqi Freedom (post-velocity management) exemplifies the change. For Operation Desert Storm, the Army prepositioned supplies of some items to support 65 days of combat. This took time and a large number of troops and equipment. Massive stockpiles were necessary because resupply times were long and unpredictable (e.g., delivery times for repair parts averaged 25 days, with much longer times common). By the start of Operation Iraqi Freedom, however, Army logistics had become so fast and reliable that only a few days of supply had to be prepositioned. Without the need to preposition large stockpiles, the Army was able to commence operations far more quickly and maneuver with greater flexibility. Both the Army and RAND won awards for this significant enhancement to U.S. military capabilities.



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## MEDICARE

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Since the inception of Medicare in 1965, RAND has worked to design, evaluate, and monitor the agency's payment systems. The Medicare Prospective Payment System (PPS) was introduced in 1983 as a way to encourage more cost-effective care. Under the PPS, each patient was classified into a diagnosis-related group on the basis of clinical information, and the hospital was paid a flat rate for patients in each group. RAND was asked to determine whether the new payment system affected the quality of hospital care for Medicare patients. It concluded that the new payment system had no negative effects on patient outcomes, but patients were more likely to be discharged in unstable condition. The prospective payment system did create disparities among different types of patients who were reimbursed at the same rate. Some patients were recovering from complicated surgeries or were very sick from multiple illnesses and required a great deal of care. RAND analyzed the data to explain these disparities and advised adjusting the payment rate schedule for catastrophically expensive cases, a move that also reduced incentives for hospitals to “dump” or skimp on care for difficult cases. Medicare has continued to turn to RAND for help in evaluating new payment arrangements—for example, bundled payments, which provide a single payment for all services related to a treatment or condition, possibly spanning multiple providers and settings. RAND continues to help Medicare understand how changes in payment policy might affect health care services for Medicare beneficiaries.



## THE HOUSING ASSISTANCE SUPPLY EXPERIMENT

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In 1970, Congress instructed the U.S. Department of Housing and Urban Development (HUD) to test the feasibility of providing low-income families with housing allowances to help them find adequate existing housing (as opposed to the then-common practice of providing them with expensive new dwellings in public housing projects). HUD responded with a four-part Experimental Housing Allowance Program, the largest part of which was designed and conducted by RAND. The Housing Assistance Supply Experiment (HASE), as RAND's project was called, determined how a full-scale allowance program, in which low-income families received cash vouchers for housing, would affect the housing markets and neighborhoods in which they were located. This alternative had been considered many times but had always been rejected because of the perceived danger that allowances spent in the private market would cause rent inflation. For five years, the experiment offered enrollment to all low-income residents of two very different metropolitan areas—Green Bay, Wisconsin, and South Bend, Indiana—promising enrollees allowances for up to ten years if they remained eligible. To qualify for an allowance, a low-income household had to live in a dwelling that met standards set by the program, but it was up to the allowance recipient to negotiate repairs with the landlord or make them independently. The program placed no restrictions on rents and did not guarantee payments to the landlord. Some 20,000 households participated, and \$32 million was paid out for housing allowances. The full-scale, open-enrollment program had no perceptible effect on rents or property values in either a tight (Green Bay) or loose (South Bend) housing market. Moreover, it proved relatively easy and inexpensive to transform substandard dwellings to standard ones when both landlords and tenants were motivated to cooperate. HASE's results supported the idea that housing allowances were a less expensive, more flexible way to assist low-income households than building new housing projects, and HASE ended up laying the groundwork for the successful Section 8 voucher system used by HUD today.



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## THE RAND PALESTINE INITIATIVE

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In 2005, RAND studied a comprehensive set of issues that would have to be addressed to create a Palestinian state that could survive and thrive—considering everything from governance, internal security, and economics to demography, water, health, housing, transportation, and education. The idea was to set aside the difficulties of borders and diplomacy and to arrive at the model of a state that could immediately begin operating on “the day after peace.” The major innovation of the idea was an infrastructural backbone called the Arc—so named because the proposed infrastructure corridor traced the natural arc in the landscape formed by the hills and mountains running the length of the West Bank. The arc was the simplest feasible shape for an innovative corridor providing transportation, water, and power to the main Palestinian towns and cities, allowing them to absorb a fast-expanding population and still grow in a sustainable manner. The Arc was visionary and ambitious to a degree, but it was built on rigorous RAND analysis of the Palestinian environment—and it was entirely plausible. The concept of the Arc and other elements of the study were briefed more than 300 times to high-level American, European, and Middle Eastern government officials, to both the president and prime minister of the Palestinian Authority, and to many Palestinian city planners, health and education specialists, and academics. A concrete image of what an independent Palestinian state could look like had enormous impact, particularly among Palestinians. Before the Arc, no detailed visual image had ever accompanied the discussion of a Palestinian state. Palestinian health planners incorporated several aspects of the plan’s health elements into their own planning processes. The Arc also factored into internal Palestinian discussions in several areas of infrastructure planning. For creating the Arc, RAND and Suisman Urban Design received several awards, including the National Honor Award for Regional and Urban Design from the American Institute of Architects.



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## PROTECTING THE NETHERLANDS FROM CATASTROPHIC FLOODS

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In 1975, RAND joined with the Rijkswaterstaat of the Netherlands to study three alternative engineering approaches to protecting the vital Oosterschelde estuary—nine kilometers wide at its mouth—from North Sea floods like the one that killed thousands of people in 1953. The well-being of the oyster and mussel industries, a rare ecological environment, and many other economic and societal factors were at stake, and the entire debate was highly politicized. RAND developed multiple methodologies for predicting the effectiveness of the alternative approaches (which included an open system with additional dikes on the periphery, an impermeable dam, and a storm-surge barrier that could open and close in response to conditions). Financial costs—as well as flood security and ecological, economic, and social consequences—were compared across the options and summarized in a novel, color-coded “scorecard” format. This RAND research was combined with various studies done by the Rijkswaterstaat in a report to the Dutch Cabinet. In 1976, the Dutch Parliament selected the storm-barrier approach based on the recommendation of the Dutch Cabinet and the research done by RAND and the Rijkswaterstaat. The storm barrier was completed in 1986 and has functioned successfully ever since.



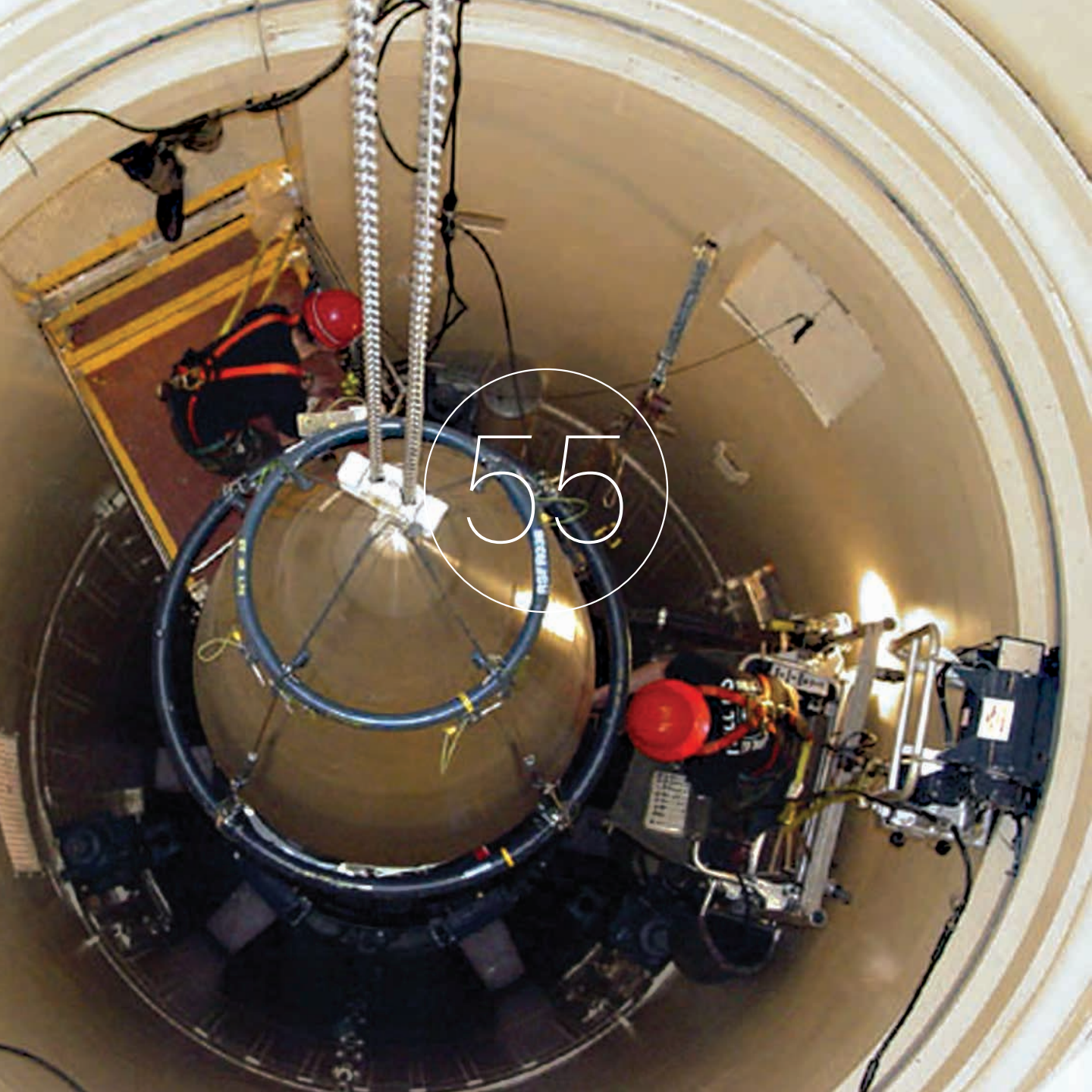
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## EXPANDING OPPORTUNITIES FOR MILITARY PERSONNEL

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The most important asset of the U.S. armed forces is people. For decades, the military services and the Office of the Secretary of Defense have turned to RAND to help design recruiting and retention policies and programs that attract the high-quality personnel on whom the services' complex systems, strategies, and overall readiness depend. RAND's work in the 1970s and 1980s included a national recruiting experiment that led to the creation of the Army College Fund. In the 1980s, as the percentage of both married soldiers and working spouses increased, RAND helped the Army revamp its family programs, such as day care, medical care, and counseling. RAND's work for the Office of the Secretary of Defense in the 1980s helped the services structure enlistment bonuses and education benefits for recruits, while studies in the 1990s estimated the effects of advertising, pay, and the external economy, helping the services respond to the drawdown and competition from the tech sector. RAND's research has also helped expand opportunities for women to serve in military occupations that were previously closed to them. RAND has helped the U.S. Department of Defense and the services establish gender-neutral occupational standards and implement policies to facilitate integration of women. In 2002, RAND research explored the reasons for lower officer promotion rates among women compared to men. More recently, it helped inform the historic decision to open all combat roles in the U.S. military to women. In 2016, RAND provided insights into the key factors surrounding the integration of women into special operations forces (SOF) positions. Researchers identified widely agreed-on professional standards for physically demanding occupations and assisted SOF service components in applying these standards to SOF occupations. Another RAND study identified issues related to the integration of women into the Marine Corps infantry. Through these and other efforts, RAND continues to support decisionmakers' efforts to monitor and manage military recruiting and retention and maintain an optimal force structure.



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## THE INTERCONTINENTAL BALLISTIC MISSILE

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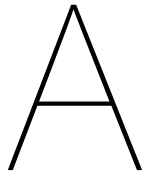
Just when the Soviet Union demonstrated its possession of an H-bomb, RAND produced what is regarded as the most important document of the missile age. The United States had, up to that point, been relying on its strategic bomber force for its nuclear capability. RAND provided all the calculations necessary to prove that it was possible, with existing technology, to build a missile capable of delivering a nuclear warhead halfway around the world. Researchers had calculated the relevant measures of feasibility, provided engineering specifications for a workable missile, described the exact guidance system that would be needed, and presented the expected accuracy. What had seemed beyond near-term attainment suddenly appeared possible within five years. RAND's work provided the impetus for development to begin on the first intercontinental ballistic missile, which gave a vital edge to U.S. defense when tensions with the Soviet Union were at a peak.



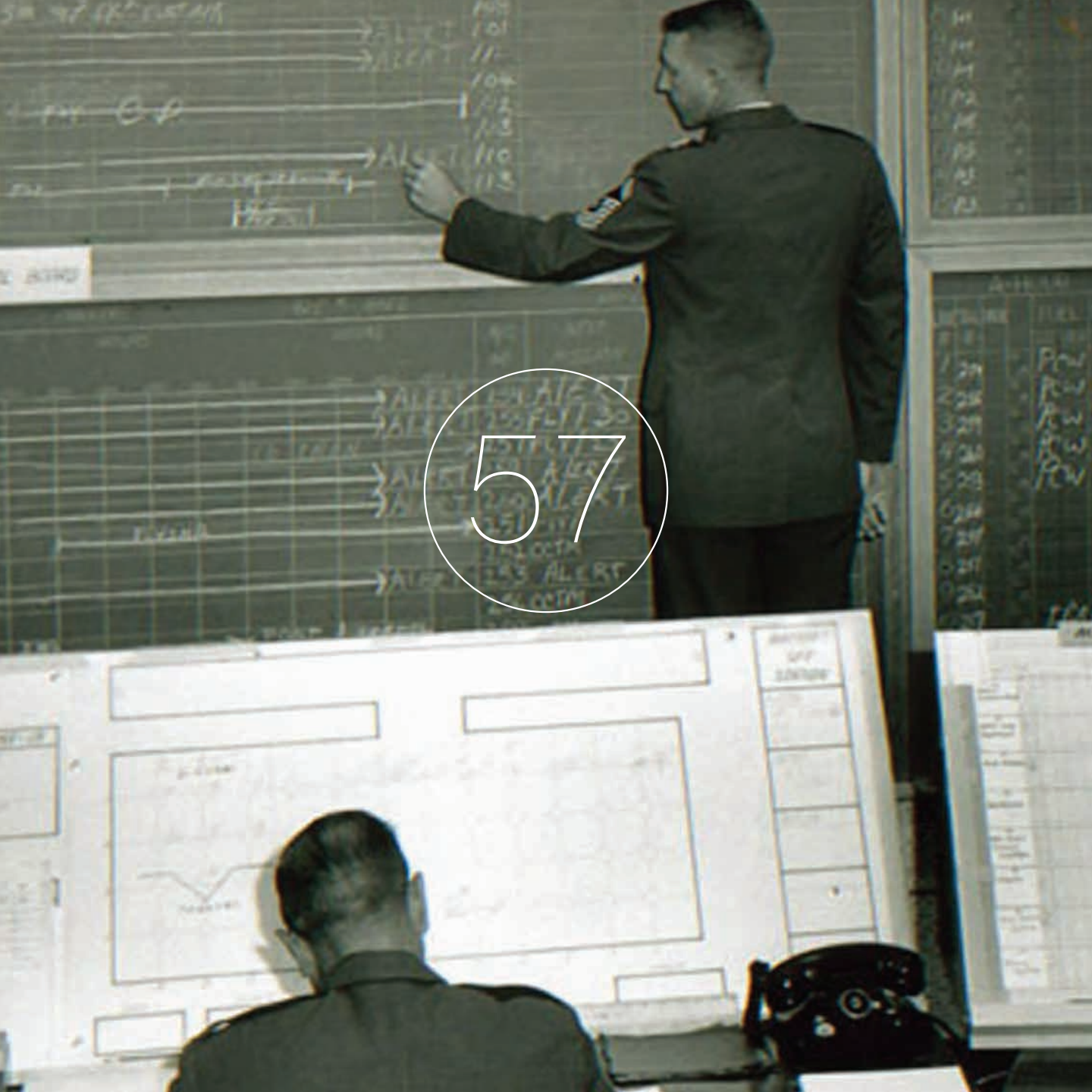
56

## A “BIG DATA” TOOL FOR ENHANCED TEXT ANALYSIS

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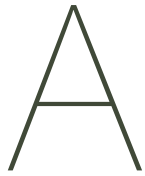
Access to “big data” from social media, archives, and other sources offers a wealth of information that can be used to understand and characterize people’s interests, communities, and perspectives. But sifting through such vast data sets in search of meaning poses a monumental analytical task. To address this challenge, a RAND team built software capable of rapidly scanning, analyzing, and coding millions of lines of text. The program, known as RAND-Lex, is able to pull out distinct words and phrases from large text collections, interpret their tone and stance (e.g., angry, inspirational), and detect argument strategies. For example, researchers used RAND-Lex to characterize the debate on Twitter between opponents and supporters of the Islamic State in Iraq and Syria (ISIS). They found, surprisingly, that ISIS opponents outnumbered supporters by six to one. They also identified multiple communities among ISIS opponents, suggesting that a one-size-fits-all approach would not be effective in countering terrorist messages. Researchers also used the tool to measure how well ISIS messages resonated with audiences in the Middle East, identifying the characteristics of ISIS speeches, proclamations, and articles that appeared to resonate. Researchers have also used RAND-Lex to examine how people talk about health and wellness, informing healthy living campaigns. The tool has also been used to examine a running online battle between Russian propagandists and Ukrainian activists. Researchers continue to add more languages and capabilities to RAND-Lex in preparation for broader use across RAND and by outside organizations.



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## COST ESTIMATION FOR WEAPON SYSTEMS

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After World War II, the United States faced the challenge of building new weapon systems that were far more complex than anything previously developed. Aircraft incorporating cutting-edge technologies were obviously going to be significantly more expensive to acquire, yet the defense budget was shrinking to peacetime levels. Cost containment became crucial, but it was an effort fraught with unknowns.

Because only fairly rudimentary cost estimation techniques existed at that time, the Air Force asked RAND to develop new ways to provide fast, reliable cost estimates for advanced systems that required extensive research, development, testing, evaluation, and, in some cases, novel manufacturing techniques. As early as 1950, RAND's Armen Alchian and future Nobel Prize winner Kenneth Arrow published the initial major treatises on the relationship between cost and quantity in the production of military airframes. By 1951, RAND researchers had studied existing data and discovered significant statistical relationships between such variables as aircraft weight and speed and the ultimate cost of the aircraft. These "cost estimating relationships" were the essence of what we now know as parametric cost estimation. Throughout the 1950s, RAND analysts developed predictive equations for many types of weapon systems. They particularly emphasized total life-cycle estimation, taking a comprehensive view by including the cost not only of developing and acquiring the weapon system but of maintaining and supporting it over time. By the early 1960s, RAND was heavily engaged in training a large cadre of Air Force and other government personnel in those techniques, institutionalizing a capability that brought clarity to resource allocation decisionmaking. The book *Cost Considerations in Systems Analysis*, which RAND published in 1970, became a standard reference for the ensuing generation of government and industry cost analysts. The parametric cost estimation methods that RAND developed are practiced to this day.



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## A SPACE-BASED MISSILE WARNING SYSTEM

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When the Soviet Union launched Sputnik in 1957 using what was essentially an intercontinental ballistic missile, the United States had no warning system for ballistic missiles used as tools of war. These weapons could hit American targets within 30 minutes of launch—much faster than traditional Soviet bombs. The United States immediately began constructing a ground-based radar system to defend against missiles. The first suggestion of a truly feasible defense came from RAND in 1955. RAND experts in infrared technology and high-altitude earth observation reported that ballistic missiles emitted detectable infrared radiation during both the boost and reentry phases and described these emissions precisely. They pointed out that, because of the curvature of the earth, a system of reconnaissance planes with infrared sensors operating at the periphery of the Soviet Union would not be able to observe the radiation. The solution, the researchers suggested, was a space-based system. They noted that, even with the difficulties of discerning infrared emissions against the background of earth and atmosphere, it was feasible for space-based sensors to detect missile launches and reentries. Because RAND was at the forefront of space research at this time, the research on infrared detection found an audience among defense decisionmakers and led directly to the development of the space-based early warning system that is still in place today.



## DETERRENCE THEORY

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After World War II, the United States faced one of the highest-stakes strategic dilemmas in human history: how to conceptualize strategic defense in the new environment of nuclear weapons. The man who would become known as a principal architect of nuclear deterrence, Bernard Brodie, was not yet at RAND, but the clarity of his thought on strategy was already evident in this now-famous statement: “Thus far, the chief purpose of our military establishment has been to win wars. From now on its chief purpose must be to avert them.” RAND quickly gathered to its ranks not only Brodie but also many of the other first-rate minds whose expertise could help formulate ideas on how nuclear conflict could be deterred, including Thomas Schelling, Albert Wohlstetter, and Herman Kahn. RAND analysts contributed cutting-edge ideas about deterrence theory and how to formulate strategies, programs, and military postures accordingly. Because deterrence exists as much in the mind as in tangible capabilities, RAND analysts became increasingly interdisciplinary, drawing not only from economics, political science, mathematics, and physics but also from individual and organizational behavior and actual historical crises. As policymakers felt increasingly imprisoned by the lack of options amid a host of possible threats, RAND was central in developing such concepts as “flexible response” and “limited nuclear options.” RAND pioneered ideas related to effective strategic competition and “crisis stability,” which sought to avoid situations that destabilized the balance of capability and vulnerability on which deterrence was predicated. In the late 1980s and 1990s, RAND developed ways to reflect issues of human decisionmaking in theories of deterrence and escalation and to extend crisis-stability concepts to conventional conflicts. With potential threats posed by new and resurgent nuclear actors (including Iran, North Korea, and Russia), deterrence theory remains relevant. RAND work continues to apply strategic analysis to international deterrence efforts, with a particular focus on the roles of both diplomacy and missile defense systems in global and regional security.



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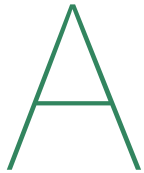
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## THE LEGACY OF 9/11

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1999 RAND study, *Countering the New Terrorism*, outlined troubling shifts in terrorist organizations and acts, including the increasing lethality of attacks; the evolution toward less hierarchical, more dispersed groups of terrorist “amateurs”; and the appeal of an “asymmetric” strategy that allowed adversaries with low-tech means to inflict considerable costs in terms of infrastructure and human lives.

Although the study proved prophetic, its greatest value was in its rational explication of the highly unconventional threat against which the United States has been trying to protect itself after 9/11. While RAND’s research on terrorism has been ongoing, the tenth anniversary of 9/11 seemed an appropriate time for a thoughtful assessment of strategy and progress in the “war on terrorism.” RAND’s leading experts collaborated on *The Long Shadow of 9/11: America’s Response to Terrorism*, which focused on the military, political, fiscal, social, cultural, psychological, and moral implications of U.S. policymaking in the wake of 9/11. Essays in the volume noted successes, including improved intelligence and strengthened public health capabilities. They also pointed to mistakes, such as overconfidence in the U.S. ability to rebuild Afghanistan and actions that aided recruiting of jihadis by fostering resentment toward the United States. The essays also examined how the shadow of 9/11 has magnified extremes within the United States, from the isolationist impulse to go it alone to the internationalist impulse to remain a beacon of freedom for the world—a conflict that has not been fully resolved. RAND research on terrorism continues apace today, and RAND researchers are routinely called upon to testify before Congress and advise the U.S. Departments of Defense, State, and Homeland Security, as well as the National Security Council and the intelligence community.



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## CORRECTIONAL EDUCATION

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In the past 40 years, the U.S. incarceration rate has more than quadrupled. While the United States represents about 5 percent of the world's population, it is home to almost 25 percent of the world's prisoners and spends more than \$60 billion annually on its penal system. Moreover, of the roughly 700,000 incarcerated individuals released back into communities each year, 40 percent will be rearrested and reincarcerated for committing crimes or violating the terms of their release. The vast majority of these individuals are undereducated, with spotty or nonexistent job histories, making employment after release a daunting possibility. Amid this bleak backdrop, RAND's analysis of the effects and costs of correctional education programs—many of which were eliminated during the 2008 economic recession—has been driving policy changes at the state and national levels. In their analysis, RAND researchers showed that prison education programs increase the odds of an individual getting a job by 13 percent, reduce the odds of an individual returning to prison by 30–50 percent, and more than pay for themselves through avoided reincarceration costs. Citing these findings, legislation in California has expanded incarcerated individuals' access to community college courses. The U.S. Department of Education subsequently implemented a pilot program to give incarcerated individuals access to federal Pell Grants to pay for college classes. And in 2018, members of Congress cited RAND's cost-effectiveness findings when introducing the Restoring Education and Learning (REAL) Act to restore Pell Grant eligibility for incarcerated individuals on a broader scale.

# Medical History

DATE OF BIRTH \_\_\_\_\_  
A IN AND AROUND YOUR MOUTH, YOUR MOUTH IS A PART OF YOUR MEDICATION THAT YOU MAY BE TAKING, COULD HAVE AN IMPORTANT BE RECEIVING THANK YOU FOR ANSWERING THE FOLLOWING

9. DO YOU BRUISE EASILY. YES  NO
10. HAVE YOU EVER REQUIRED A BLOOD TRANSFUSION. YES  NO
11. HAVE YOU HAD A RECENT WEIGHT LOSS. YES  NO
12. HAVE YOU EVER TAKEN FEN-PHEN OR REDUX. YES  NO
13. DO YOU USE TOBACCO. YES  NO
14. DO YOU OR HAVE YOU USED CONTROLLED SUBSTANCES. YES  NO
15. ARE YOU WEARING CONTACT LENSES. YES  NO
16. DO YOU HAVE ANY DISEASE PROBLEM NOT LISTED ABOVE. YES  NO
17. SHOULD KNOW ABOUT \_\_\_\_\_

18. ONLY: YES  NO
19. YOU PREGNANT OR THINK YOU ARE PREGNANT. YES  NO
20. ARE YOU NURSING. YES  NO
21. ARE YOU TAKING BIRTH CONTROL. YES  NO

22. SKIN RASH. YES  NO
23. OR DIZZY SPELLS. YES  NO
24. INFECTION. YES  NO
25. OR BLEMS. YES  NO

26. RHEUMATISM. YES  NO
27. OR IMPLANT. YES  NO

28. CES BLOOD. YES  NO
29. (CANCER, LEUKEMIA). YES  NO
30. OR DISEASE. YES  NO



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# HEALTH INSURANCE CLAIM FORM

1. MEDICARE (Medicare #) _____	MEDICAID (Medicaid #) _____	CHAMPUS (Sponsor's SSN) _____	CHAMPVA (VA File #) _____	GROUP HEALTH PLAN (SSN or ID) _____	FECA BUX (LUNG) (SSN) _____	OTHER (ID) _____	18. INSURED'S I.D. NUMBER _____		
2. PATIENT'S NAME (Last Name, First Name, Middle Initial) _____				3. PATIENT'S BIRTH DATE MM   DD   YY M   F		SEX _____	4. INSURED'S NAME (Last Name, First Name, Middle Initial) _____		
5. PATIENT'S ADDRESS (No., Street) _____				6. PATIENT RELATIONSHIP TO INSURED Self _____ Spouse _____ Child _____ Other _____		7. INSURED'S ADDRESS (No., Street) _____	19. INSURED'S DATE OF BIRTH MM   DD   YY		
CITY _____	TELEPHONE (_____) _____	8. PATIENT STATUS Single _____ Married _____ Other _____		9. OTHER INSURED'S NAME (Last Name) _____		CITY _____	20. EMPLOYER'S NAME OR SCHOOL _____		
ZIP CODE _____	10. IS THIS CONDITION RELATED TO: YES _____ NO _____			11. INSURED'S POLICY GROUP OR FECA NUMBER _____		21. INSURED'S DATE OF BIRTH MM   DD   YY	22. EMPLOYER'S NAME OR SCHOOL _____		
9. OTHER INSURED'S NAME (Last Name) _____		12. IS THIS AN ACCIDENT? YES _____ NO _____		13. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____		23. INSURED'S OR AUTHORIZED REPRESENTATIVE'S SIGNATURE _____			
10. OTHER INSURED'S DATE OF BIRTH MM   DD   YY		14. RESERVED FOR LOCAL USE _____		15. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____		24. PATIENT'S SIGNATURE _____			
11. OTHER INSURED'S NAME (Last Name) _____		16. RESERVED FOR LOCAL USE _____		17. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____		25. PATIENT'S SIGNATURE _____			
12. OTHER INSURED'S DATE OF BIRTH MM   DD   YY		17. RESERVED FOR LOCAL USE _____		18. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____		26. PATIENT'S SIGNATURE _____			
13. EMPLOYER'S NAME OR SCHOOL NAME _____		18. RESERVED FOR LOCAL USE _____		19. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____		27. PATIENT'S SIGNATURE _____			
14. INSURANCE PLAN NAME OR PROGRAM NAME _____		19. RESERVED FOR LOCAL USE _____		20. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____		28. PATIENT'S SIGNATURE _____			
15. BEFORE COMPLETING & SIGNING THIS FORM, I authorize the release of any medical or other information at payment of government benefits either to myself or to the party who accepts				21. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____				29. PATIENT'S SIGNATURE _____	
16. READ BACK OF PAGE _____				22. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____				30. PATIENT'S SIGNATURE _____	
17. SIGNATURE _____				23. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____				31. PATIENT'S SIGNATURE _____	
18. DATE _____				24. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____				32. PATIENT'S SIGNATURE _____	
19. DATE _____				25. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____				33. PATIENT'S SIGNATURE _____	
20. DATE _____				26. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____				34. PATIENT'S SIGNATURE _____	
21. DATE _____				27. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____				35. PATIENT'S SIGNATURE _____	
22. DATE _____				28. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____				36. PATIENT'S SIGNATURE _____	
23. DATE _____				29. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____				37. PATIENT'S SIGNATURE _____	
24. DATE _____				30. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____				38. PATIENT'S SIGNATURE _____	
25. DATE _____				31. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____				39. PATIENT'S SIGNATURE _____	
26. DATE _____				32. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____				40. PATIENT'S SIGNATURE _____	
27. DATE _____				33. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____				41. PATIENT'S SIGNATURE _____	
28. DATE _____				34. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____				42. PATIENT'S SIGNATURE _____	
29. DATE _____				35. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____				43. PATIENT'S SIGNATURE _____	
30. DATE _____				36. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____				44. PATIENT'S SIGNATURE _____	
31. DATE _____				37. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____				45. PATIENT'S SIGNATURE _____	
32. DATE _____				38. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____				46. PATIENT'S SIGNATURE _____	
33. DATE _____				39. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____				47. PATIENT'S SIGNATURE _____	
34. DATE _____				40. IS THERE ANOTHER HEALTH BENEFIT PLAN? YES _____ NO _____				48. PATIENT'S SIGNATURE _____	
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## COMPARE

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In 2009, RAND launched the COMPARE website to provide objective, nonpartisan analysis to inform public dialogue on health care reform. The centerpiece of COMPARE (Comprehensive Assessment of Reform Efforts) was a policy option “dashboard” that offered both a snapshot and an in-depth look at the implications that various policy changes could have on a range of outcomes, such as costs, quality of care, and access to care. COMPARE’s microsimulation model was an important tool in assessing alternative design features of the Patient Protection and Affordable Care Act (ACA), signed into law in 2010. Also known as Obamacare, the ACA was intended to reduce the number of uninsured, make coverage more affordable, and expand access to care. The ACA also mandated new approaches to reducing costs and improving quality, including reducing payments to hospitals for some Medicare services and experimenting with new payment and delivery models. RAND used COMPARE to understand the impact of these features and to monitor the ACA’s overall effects. The Trump administration and the Republican majority in Congress subsequently put forward several proposals to repeal, replace, repair, or improve the health reform law. Drawing on COMPARE’s flexible design, RAND then offered insights about the likely impact of repealing or revising ACA provisions on Medicaid, the individual mandate, employer requirements, tax subsidies, rate regulations, essential health benefits, and more. COMPARE has also modeled state-level effects, including Medicaid expansion, enrollment in the exchanges, the cost of premiums, and employer offerings of insurance. COMPARE is built to last, and RAND will continue to use the tool to assess proposed revisions to the ACA or replacements for the health law.



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February

March

## TAKING AMERICA'S PULSE

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Since 2003, the innovative RAND American Life Panel (ALP) has used a nationwide panel survey to provide critical insights on topics as diverse as the 2008 economic crisis, health care reform, and presidential voter preferences. Many surveys present snapshots of public opinion, but the ALP can also capture how attitudes are being shaped and shifted by outside forces—from world events to local politics. Unlike many other polls that use new random samples each time they poll, the ALP can survey the same panel of up to 6,000 people over time. The surveys are conducted online rather than by telephone—an important innovation that better aligns with modern communication habits. To ensure that ALP surveys accurately represent the U.S. population, RAND provides laptops and internet connections to participants who otherwise would not have them. Before the 2016 presidential election, the ALP's panel approach allowed RAND researchers to link individuals' preexisting attitudes and beliefs to their support for each candidate and track how these perceptions and support for policies changed over time. Amid the implementation of the Affordable Care Act in 2010, RAND's survey uncovered a fundamental problem: Many newly insured Americans were unprepared to make informed decisions about their own health care. More than 40 percent could not correctly define a deductible. The result was a public-information campaign that translated health care and insurance basics and benefits into plain English. More recently, seeing the need for clear information about how curriculum mandates like Common Core were working in the classroom, RAND created a new survey panel of teachers (the American Teacher Panel) and school leaders (the American School Leader Panel) to obtain accurate firsthand information about teachers' and school leaders' evolving knowledge of methods, mandates, and resources, as well as their actual attitudes, their everyday practices, and the conditions under which they work.



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## THE COST OF SLEEP DEPRIVATION

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What is the value of a good night's sleep? This problem was considered incalculable until RAND Europe researchers developed an innovative approach that put a monetary value on sleep deprivation. RAND found that the United States sustains, by far, the highest economic losses from sleep deprivation—as much as \$411 billion a year and 1.2 million lost workdays.

The findings underscored the importance of sleep-friendly work policies, such as fewer after-hours interruptions and flexible scheduling. A lack of sleep can also be a problem for youth, negatively affecting academic performance and physical and mental health. RAND also conducted the first state-by-state economic analysis of the effect of delaying school start times, which would allow teens to get more sleep at a time of day when research indicates their bodies need it the most. Researchers found that shifting school start times to at least 8:30 a.m. could boost the U.S. economy by \$83 billion within a decade through higher academic performance, reduced car accidents, and other benefits. Extensive media coverage of the RAND studies, along with a TED Talk that has received more than 2.3 million views (and counting), has helped bring attention to sleep deprivation, which previously received little policy attention. School districts in several states have recently changed their start times to allow teens more sleep, and state legislatures have introduced bills to mandate later school times or study the effects of new policies.



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## CHINA'S MILITARY MODERNIZATION

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China has become one of the fastest-growing military powers in the world, and RAND has closely monitored this trend and its implications for the United States and its allies. RAND experts, drawing on Chinese political, military, and academic documents, observed the increasing professionalism and influence of China's military; the evolution of a more assertive foreign policy; and the formulation of a military strategy designed to deter, delay, or defeat a U.S. military response to a contingency in the Asia-Pacific region. Researchers also charted China's massive investment in air, sea, land, space, cyber, and missile capabilities. A landmark report synthesized these trends in the form of an easy-to-interpret "scorecard" quantifying and tracking the relative strength of Chinese and U.S. military capabilities across the warfighting domains from 1996 to 2017 and into the future. A key finding was that China still lags behind the United States in some areas but is rapidly closing these gaps. The scorecard was the first comprehensive, comparative assessment of Chinese military modernization available to the general public. This body of RAND research is helping U.S. policymakers balance the objectives of positive engagement with China, deterrence to prevent conflict, and continued protection of key allies.



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## SUPPORT FOR SERVICE MEMBERS, VETERANS, AND THEIR FAMILIES

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Researchers at RAND have developed a range of tools and resources to help service members, veterans, and their families cope with the effects of deployments, physical and psychological injuries, and other challenges. RAND conducted the first-of-its-kind longitudinal study of military families, which examined how deployments affect health and well-being. This effort identified factors, skills, and tools that helped families cope with stressors. A comprehensive RAND evaluation of mental health and substance use treatment offered by the U.S. Department of Veterans Affairs found that quality fell short of the high standards set in its guidelines. These findings were used to expand capacity and improve the quality of care. After a disturbing increase in military suicide rates, a RAND study revealed differences in how the service branches approached suicide prevention. This research led to such reforms as a standard prevention approach incorporating RAND-identified best practices. RAND has also developed tools to connect the military community with resources and support, including an online searchable database of programs addressing psychological health and traumatic brain injury and guides to help service members and families navigate clinical services. And a landmark RAND study on military caregivers raised awareness of the role played by the spouses, parents, and friends who care for wounded, ill, and injured military personnel and veterans. The findings and recommendations have led to the launch of a new congressional caucus, a multisector coalition to address caregiver needs, a peer-based social support network, and a national campaign urging employers to implement caregiver-friendly policies.



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## COUNTERING RUSSIAN PROPAGANDA

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As policymakers investigated Russia's hacking of U.S. political systems, Russian propagandists were at work across a wide front, aiming what RAND analysis called a "firehose of falsehood" at ill-prepared audiences in the United States and abroad. The analysis, conducted in 2015 and published in mid-2016, highlighted a remarkable evolution in Russian propaganda. A second RAND project using the text analysis tool RAND-Lex visualized the impact of Russia's employment of new dissemination modes and approaches, including Twitter bots and troll farms, to garner support for its 2014 annexation of the Crimean Peninsula among near-neighbors Ukraine, Belarus, Moldova, and the Baltic States. The Russian propaganda model is high-volume and multichannel, and it disseminates messages without regard for the truth. It is also rapid, continuous, and repetitive, and it lacks commitment to consistency. Although some of these features would seem to run counter to the received wisdom for successful information campaigns, RAND noted that research in psychology supports many of the most successful aspects of the model. Furthermore, the very factors that make the firehose of falsehood effective also make it difficult to counter. Traditional counterpropaganda approaches have proven inadequate in this context. RAND found that the same psychology literature that explains the surprising success of the Russian propaganda model and its misleading messages points to more-effective solutions to counter them. RAND's insights were briefed to senior U.S. military officials, foreign governments, and other influential audiences to help them develop and refine strategies to address this difficult challenge. After the firehose was turned on the United Kingdom's referendum on leaving the European Union, the U.S. presidential election, and France's presidential election, RAND's analysis was termed prescient, and its insights into Russia's propaganda model garnered even wider attention.



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## A CULTURE OF HEALTH

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**B**ecause health is a function of more than medical care, solutions to U.S. health problems must encompass more than reforms to health care systems. But those working to improve health, well-being, and equity often find themselves traveling on parallel paths that rarely intersect, resulting in health outcomes and costs that have not changed much. In 2013, the Robert Wood Johnson Foundation (RWJF) embarked on a pioneering effort to advance what it called a Culture of Health. The vision is based on a cultural shift in which individuals, communities, and organizations actively prioritize and promote enhanced well-being and view health as fundamental to the nation's social and economic future. RAND worked with RWJF to develop an action framework to translate this vision into action. The framework—now used by states, schools, businesses, and other organizations—focuses on making health a shared value, fostering cross-sector collaboration to improve well-being, creating healthier and more equitable communities, and strengthening the integration of health services and systems. RAND engaged stakeholders and fielded surveys on public attitudes regarding health priorities, the role of community health, and government and private-sector involvement. RAND has also used Twitter and Google data to develop new measures to track sentiment on health care promotion and treatment and to capture federal investments in health that go beyond health care spending. These measures are creating common terms for discussion across sectors and catalyzing social change. RAND's collaboration with RWJF has emphasized the importance of community engagement and well-being in improving population health into the future.



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## TOOLS TO PRESERVE THE LOUISIANA COASTLINE

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Coastal Louisiana has been facing risks from rising seas and intense tropical storms and experienced a dramatic loss of its land and diverse habitats to open water. Since 2010, RAND has been a key partner in helping the Louisiana Coastal Protection and Restoration Authority develop its long-term Comprehensive Master Plan for a Sustainable Coast. The plan calls for the investment in flood risk reduction and ecosystem restoration while targeting high-risk and economically vulnerable areas. To support Louisiana, RAND built two tools: an interactive planning tool to compare proposed solutions and understand complex trade-offs and a cutting-edge model to evaluate flood risk under different conditions. The tools helped Louisiana put politics aside and rely on an objective, quantitative foundation for selecting projects to fund under the 50-year, \$50 billion 2012 Coastal Master Plan. Projects focused on restoration (through such efforts as river diversions and marsh creation), as well as both structural and nonstructural risk reduction. After the state's 2015 gubernatorial election, with control shifting from one party to another, the state continued to work with RAND to refine the planning tool and improve the flood risk model. The 2017 Coastal Master Plan improved on the 2012 plan by taking into account updated estimates of plausible future conditions and presenting an updated set of projects for implementation. The Louisiana House joined the Louisiana Senate and unanimously approved the 2017 plan. The state continued to implement the plan and dedicated \$644 million to coastal restoration projects in 2018. A 2023 Coastal Master Plan is building upon previous master plan efforts and strives to ensure that the collective effects of project investments reduce storm surge-based flood risk to communities, provide habitats to support an array of commercial and recreational activities, and support infrastructure critical to the working coast.



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ROGERS  
US COAST GUARD

WELLS  
US COAST GUARD



## DIVERSITY IN THE MILITARY

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special commission on military diversity, backed by RAND research, was unsparing in its final assessment. U.S. armed forces, it declared in 2011, had failed to develop leaders “who are as diverse as the nation they serve.” RAND has worked with the U.S. Department of Defense (DoD) and individual service branches since then to remove barriers and promote policies to help women, racial and ethnic minorities, and other underrepresented service members succeed. The commission, staffed by more than a dozen RAND researchers, successfully pushed for women to be allowed to serve in combat positions. That was its most visible recommendation, but its impact was even more far-reaching. It redefined military diversity as integral to overall readiness and called for strengthening every rung of the career ladder with an eye toward recruiting and retaining a diverse force. A follow-on RAND report provided a framework to help DoD work through the commission’s findings. It organized DoD efforts around “three C’s”: compliance, communication, and coordination. In subsequent reports, RAND helped DoD improve its efforts to attract a diverse workforce in science and technology fields and helped the Department of the Air Force bring more-diverse candidates into its leadership pipeline. Researchers showed that up to half of Air Force general officers were fighter pilots; only 2 percent of underrepresented demographic groups were. Outside DoD, the Coast Guard also turned to RAND for help shoring up its retention of women. RAND’s findings prompted the service to update its parental-leave policies, to eliminate gender-specific pronouns from evaluations and promotion packages, and to create a pilot program to assess fitness rather than body composition. RAND also carried out a pivotal study for DoD on the potential costs and readiness implications of allowing transgender service members to serve openly. Researchers found the costs would be “overwhelmingly small” and the impact on readiness would be minimal. The Pentagon cited RAND’s findings when it lifted its ban on transgender service members in 2016.



## A NEW WAY TO QUANTIFY U.S. INCOME INEQUALITY

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Few U.S. workers have seen the economic growth of recent decades reflected in their paychecks. As part of a broader effort to better understand how inequality and inequity play out in the lives of Americans, RAND developed a new way to measure how much that has cost all but the highest earners. The answer: around \$50 trillion. Researchers asked a simple question: What would incomes look like if they had grown at the same rate as the U.S. economy? That was the trend in the first two decades after World War II. During the 1960s, in fact, incomes for the lowest-paid workers grew faster, reducing income inequality. But income growth slowed for most workers in the '70s while it accelerated for the highest earners. A worker who made the inflation-adjusted equivalent of \$28,000 in 1975, for example, was only making \$33,000 in 2018. Economic growth over the same time period was just under 120 percent: If incomes had kept pace, that same worker would have made \$61,000 in 2018. Meanwhile, someone who made \$257,000 in 1975 would have made \$560,000 if incomes followed the economy—but actually made \$761,000. So the top 1 percent of earners went from taking home 9 percent of total income to 22 percent. RAND looked specifically at taxable income, which includes wages and salaries as well as interest, rents, and dividends. It found that income growth for the lowest 25 percent of earners was driven almost entirely by women working more hours. It also found that the earnings gap between White and Black men narrowed at most income levels but remained or even grew among the highest earners. In fact, the story was remarkably consistent across all income levels except for the top 10 percent. With few exceptions, incomes never came close to the economic growth rate after 1975. If they had, the bottom 90 percent of earners would have made an additional \$2.5 trillion in 2018 alone—and \$47 trillion since 1975. With this analysis, RAND, according to *Time* magazine, “brings the inequality price tag directly home by denominating it in dollars—not just the aggregate \$50 trillion figure, but in granular demographic detail.”



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## MILITARY INVESTMENTS IN ARTIFICIAL INTELLIGENCE

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ong-term strategic competitions with China and Russia are among the principal priorities for the U.S. Department of Defense (DoD). All three nations are developing artificially intelligent computer systems that will transform the 21st-century battlefield. In response to a congressional mandate, RAND researchers laid out a path to help DoD better align its actions and investments with its strategy. DoD has defined artificial intelligence, or AI, as the ability of machines to perform tasks that normally require human intelligence. With AI as a cornerstone of its future planning, DoD established the Joint Artificial Intelligence Center to advance research and innovation—yet has not given the center the visibility or budget authority to carry out its mission. RAND recommended that DoD develop a multiyear road map for how the center will push forward AI technology, with the resources and metrics to ensure it stays on target. Researchers also urged DoD to work more closely with outside scientists and private industry to better validate and test emerging technologies while also cultivating AI talent within its own workforce. Such investments in AI will likely pay off in the short term in mostly back-office applications, such as improving financial and personnel management. In the middle term, those investments might yield mission-support applications, such as computer systems that can help human analysts review overhead videos. But the more ambitious uses of military AI, such as autonomous air-defense systems, will require long-term investments and commitments. RAND research and analysis are helping DoD stay realistic about the challenges ahead while recognizing incremental breakthroughs and helping to create greater opportunities for innovation.



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## AN ALL-VOLUNTEER FORCE IN THE U.S.

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In 1971, when the Vietnam War was at peak intensity and the United States was moving to implement an all-volunteer force (AVF), the Advanced Research Projects Agency in the U.S. Department of Defense (DoD) asked RAND to establish a manpower research center that would include economists, cost analysts, operations researchers, and computer scientists. At first, the center's findings and recommendations were used to manage the transition to the AVF. Later studies focused on the unique problems of the reserve components and were used to establish new recruiting programs. RAND's research on the recruiting and retention of medical personnel resulted in new scholarship and bonus programs and suggested an expanded role for "physician extenders." Research on the effects of paid advertising and military personnel's retention and reenlistment decisions fundamentally changed how the force was managed. Most noteworthy was a study of the AVF's first five years that was briefed to Congress and used by the Carter administration to underpin its early policies. In the 1980s, RAND evaluated programs to improve the quality of new recruits and foretold the 1991 performance of U.S. troops in Operation Desert Storm—performance that brought an end to lingering doubts about the level of quality that could be sustained with a volunteer force. In 2001, RAND analysis was used to fundamentally change the structure of the military pay table, the benefits of which can be seen in the extremely high retention even in the face of the lengthy combat operations in Afghanistan and Iraq. A side benefit of RAND's continuous manpower policy research programs has been the training of numerous experts who have become senior DoD decisionmakers.



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## GUN POLICY IN AMERICA

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The debate over gun policy in America suffered for years from a dearth of high-quality research and analysis. RAND made it an institutional priority to fill that vacuum, to provide a shared set of facts that the public and policymakers could use to develop fair and effective gun policies. Based on a review of thousands of studies, researchers found supportive evidence that child-access prevention laws could reduce firearm injuries among young people and that stand-your-ground laws increase homicides. But for many other common gun policies—from assault-weapon bans to gun-free zones—the evidence was insufficient to say whether they would have any effect. It wasn't that those policies had been shown not to work; in most cases, they had never been tested in a rigorous way, in part due to methodological challenges and gaps in data availability. To provide direction for future studies, researchers surveyed nearly 200 experts across the ideological spectrum to identify areas of consensus or opportunities for compromise. They found there were generally two ideological camps—one that favored more-restrictive regulatory approaches to guns and one that favored more-permissive approaches. But both camps largely agreed that the top priority for policymakers should be preventing firearm homicides, followed by preventing suicides and protecting privacy rights. They disagreed on which policies would accomplish those goals. Researchers developed a set of tools and resources for the field that could shed light on how policymakers could best achieve those shared objectives. Those include new datasets measuring state-level firearm laws, firearm injury hospitalization rates, and household gun ownership rates. They also used novel methods to provide more-rigorous evidence for the effects of commonly implemented laws that regulate firearm use, storage, and carrying behavior. Their work has been followed by a resurgence in federal funding for firearm violence prevention research. Congress, whose limits on such research had amounted to an outright ban since the 1990s, has since 2019 allocated \$25 million annually for new studies.



# TRUTH DECAY

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## TRUTH DECAY

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The quality of public discourse in the United States has declined over the past two decades, imposing real costs on American society—and threatening democracy as we know it. The spread of false information, an inability to agree on a common set of facts, deep polarization, and other troubling trends mark this decline. RAND recognized the need to better understand this problem and responded with *Truth Decay: An Initial Exploration of the Diminishing Role of Facts and Analysis in American Public Life*. Published in 2018, it is the most comprehensive framework to date for analyzing the causes and effects of this complex phenomenon. The report established a common vocabulary for deeper study of key issues, including the effects of social media, perceptions about the news, and declining trust in the government and media. Looking back at American history, RAND identified other historical periods marked by Truth Decay. However, the current era stands out in one key way: People disagree over objective facts and data. RAND’s research found that past Truth Decay eras ended when government and other institutions increased transparency and when Americans attached more value to objectivity. In more than a dozen subsequent reports, researchers have examined how Truth Decay creeps into classrooms, newsrooms, online spaces, and communities. One RAND survey found that many Americans are skeptical about the reliability of the news; yet one-third of the respondents said they still use sources they consider less than reliable. Researchers also identified potential ways to counter Truth Decay. They created a framework to measure “civic infrastructure,” the places, policies, programs, and practices that foster civic engagement. They flagged online disinformation campaigns by China and Russia and built a database of online tools designed to counter such efforts. And they looked at the state of civic education in America—not just providing recommendations to strengthen it, but also developing a set of lesson plans to give students the tools to fight Truth Decay in their own lives.

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