U.S. Commanders Need Flexible Ways to Manage Personnel
—By Beth Asch and James Hosek

A Matter of Class: Educational Achievement Reflects Family Background More Than Ethnicity or Immigration—By Sandraluz Lara-Cinisomo, Anne R. Pebley, Mary E. Vaiana, Elizabeth Maggio, Mark Berends, and Samuel R. Lucas

Public Initiative: What the “Gene Revolution” Can Learn from the Green Revolution—By Felicia Wu and William P. Butz
Message from the Editor

Our cover photograph depicts the firm yet disquieting position in which U.S. troops often find themselves today, both in wartime and in peacetime. The troops belong to an unwavering and unrivaled military force, and yet the unwavering stance itself could become a source of weakness in a world of unknowable threats.

The photograph symbolizes both what is right and what is wrong with the current management of U.S. military personnel. On the one hand, the military compensation and personnel system puts every member of every service on an essentially equal career footing, affords everyone similar opportunities, and rewards everyone rather fairly, either as officers or as enlisted personnel. As a rule, the system is stable, predictable, and equitable.

On the other hand, the system does not give commanders the flexibility to manage personnel in different occupations differently, despite huge occupational differences in skills, aptitudes, and competing civilian opportunities. U.S. personnel themselves need to be flexible, creative, innovative, entrepreneurial, and ready to take intelligent risks. But the personnel system offers few incentives to promote these characteristics. As a rule, the system is fixed, rigid, and unyielding.

The challenge for military commanders today is to retain the stability and equity of the existing compensation and personnel system while accommodating the flexibility and creativity required for meeting the larger goal of military transformation. Our cover story by Beth Asch and James Hosek offers a set of proposals to help commanders strike the proper balance.

Our two other feature stories address equally unintended imbalances. The story on family background argues that national and statewide efforts intended to boost educational achievement among racial and ethnic minorities should place a heavier weight on improving the socioeconomic conditions and educational opportunities that often correspond with the racial and ethnic achievement gaps. The story is a joint effort by two teams of researchers—one led by Sandraluz Lara-Cinisomo, the other by Mark Berends.

In our third feature story, Felicia Wu and William Butz point out that an imbalance of initiative has stalled global progress toward an agricultural revolution that could ease hunger for hundreds of millions of people. Too much of the initiative has come from private industry. Too little of the initiative has come from public policy.

—John Godges
Americans continue to express “high levels of support” for health insurance coverage of family planning services in the United States, but support for U.S. funding of family planning and abortion services in developing countries is “declining,” said Clifford Grammich, lead author of a new RAND study comparing responses in public opinion surveys conducted in 1998 and 2003.

In both surveys, the study found that more than five in six Americans favored requiring U.S. health insurers to “cover family planning services, just like other doctor’s visits and services, as part of their regular health care coverage.” Slightly less than half of U.S. workers with health insurance plans have coverage for abortion services, according to Grammich.

But public support for U.S. funding of international family planning dropped significantly, from 80 to 69 percent in the time between surveys. Opposition to U.S. government funding for both international family planning and abortion increased significantly. Only 45 percent of Americans support U.S. funding for voluntary abortion services overseas increased from 46 to 52 percent, while those in strong opposition to the policy grew from 33 to 40 percent.

Respondents were asked for their view of a current federal policy requiring nongovernmental organizations to agree, as a condition of receiving U.S. government funds for international family planning programs, that they will neither perform nor promote elective abortion. While support for this policy has remained steady across the two surveys, opinion has become more ideologically polarized. This has not been the case for domestic family planning policies. ■


Letters to the Editor

The article, “Five Pillars of Democracy: How the West Can Promote an Islamic Reformation” (Spring 2004 RAND Review), is interesting. It seems the writer has done a thorough study of Muslim societies. At least she does not have a jaundiced view, as other writers of the West generally tend to have. She has aptly classified people into four categories, and I think this is a model through which any society could be described.

I think the traditionalists and modernists should be encouraged. The traditionalists may be responsible for stagnation in their societies, but they do no harm to others, whereas the modernists keep changing with time. We should not forget that they are all Muslims, and they will do their best to improve and modernize their societies, if the West will promote them.

But I have doubts that Western leaders will accept the suggestions made by the writer. The world community—read, the United States of America—promotes extremism, dictatorship, and corruption while preaching democracy, freedom, and all the good things the West is dedicated to in its society.

Why is there so much bad blood among brothers? You have answered my question: “The West needs to adhere consistently and faithfully to its core values of democracy, equality, individual freedom, and social responsibility.”

Mohammad Waqas
Associate Copy Editor, India Today
New Delhi, India

RAND Review is an excellent social science and public policy effort that merits wide attention from the media as well as decisionmakers. In this connection, your symposium in the Summer 2004 issue on the American legal system (“Trials and Tribulations: Expert Witnesses Chart the Future of American Civil Justice”) is pointed and very much on target.

Irving Louis Horowitz
Chairman of the Board and Editorial Director
Transaction Publishers
Rutgers—The State University of New Jersey
Piscataway, New Jersey
Starting Kids Later in Kindergarten Yields Cognitive Benefits But Increases Child Care Costs

Studies have shown that older entrants to kindergarten perform better than younger ones, but do these gains persist over time? And if such gains persist, what types of kids benefit the most?

“Kids who enter kindergarten at age 6 instead of age 5—especially kids from disadvantaged families—do significantly better on standardized tests, and the gains persist beyond kindergarten,” said Ashlesha Datar, a RAND associate economist and author of a study examining the benefits and costs of delaying kindergarten entrance age. The study uses a nationally representative sample of kindergartners.

A one-year delay in kindergarten entrance increases math and reading scores significantly. As shown in the figure, which plots the scores on standardized math and reading tests at two points in time—once at the start of kindergarten and again at the end of first grade—such gains persist beyond kindergarten for both poor and nonpoor children.

The study also shows that the benefits of delaying kindergarten are even greater for children from poor families. While children who are not poor always start off better than poor ones regardless of the age at which they enter kindergarten (shown by the dots), delaying kindergarten entrance from age 5 to age 6 among poor children also increases their subsequent gains in math and reading test scores (shown as the distance between the dots and x’s).

This trend is most notable in looking at math score gains: Poor children entering at age 5 have almost no gain between testing periods, while those entering at age 6 have a much larger gain. There is also greater improvement in reading scores. By contrast, both younger and older entrants from families who are not poor gain the same amount between testing periods.

But delaying kindergarten has a cost, especially for poor families, because families must pay for additional child care costs for children who do not enter school until one year later. The study simulated how potential changes in state policies on kindergarten entrance age would affect child care costs for families.

Eight states with earlier kindergarten entrance ages are currently considering requiring that children start kindergarten at age 6. If that policy were implemented, it would affect more than 90,000 students and lead to $115 million in additional child care costs for families whose children would otherwise enter kindergarten at age 5.

“These findings suggest that policymakers may need to view entrance age policies and child care policies as a package,” Datar said.

For more information: The Impact of Changes in Kindergarten Entrance Age Policies on Children’s Academic Achievement and the Child Care Needs of Families (RAND/RGSD-177).

“A One-Year Delay in Kindergarten Entrance Increases Math and Reading Scores

Suburban Sprawl Can Be Bad for Your Health, Study Finds

“Suburban sprawl is linked to the prevalence of many chronic health ailments,” said Roland Sturm, a RAND economist and coauthor of a new study that for the first time analyzes suburban sprawl and a broad range of chronic health conditions.

The study defines suburban sprawl as urbanized areas with separated residential, shopping, and business districts; limited street connections (because, for example, of more cul-de-sacs); and lower population density.

The study used a nationally representative survey that asked adults about a variety of issues related to chronic medical conditions, mental health disorders, and health-related quality of life. The study analyzed information from more than 8,600 people in 38 U.S. metropolitan areas rated by four sprawl measures: (1) residential density, (2) the mix and balance of land uses, (3) the proportion of development in regional cores and subcenters, and (4) street accessibility.

As shown in the figure, the study found that people who live in areas with a high degree of suburban sprawl are more likely to report one or more of 16 chronic health conditions (such as arthritis and diabetes) than people who live in less sprawling areas. The differences reflect the effects of sprawl after accounting for factors—such as age, economic status, race, and the local environment—that could otherwise explain the differences.

The findings suggest that an adult who lives in a more sprawling city such as Atlanta will have a health profile similar to someone who is four years older—but otherwise similar—living in a more compact city such as Seattle. The study also found that the unhealthful consequences of suburban sprawl disproportionately affect the poor and the elderly, who often have fewer resources to make up for the limitations created by the suburban environment.

In contrast, while many researchers have proposed that suburban sprawl results in social isolation that may lead to more mental health problems among suburbanites, the study found no differences in the rates of depression, anxiety, or psychological well-being among people who live in urban versus suburban settings.

“If future research confirms our initial results,” Sturm said, “policies that address the built environment can play a critical role in the prevention of a wide variety of chronic diseases.”


An adult who lives in a more sprawling city will have a health profile similar to someone who is four years older living in a more compact city.
Faster Passenger Check-In Can Make Airport Less Vulnerable

There are cost-effective, short-term measures available to improve airport security and reduce the impact of a potential terrorist attack at Los Angeles International Airport. "Reducing lines at the airport could greatly reduce the number of people exposed to a terrorist attack, and the cost of such a reduction is surprisingly low," said Donald Stevens, a RAND senior analyst.

The challenge in meeting a terrorist threat is to influence the behavior of an unpredictable enemy—to make terrorists see the airport as an undesirable target that is not worth their effort. In this light, researchers examined a number of plausible attack scenarios (as shown in the figure) and concluded that various kinds of potential bomb attacks present the greatest and most plausible risks. The major threats include bombs placed on airplanes—either as cargo or by an insider who plants a bomb without boarding—and bombs placed in vehicles or in luggage around the airport.

Given the scenarios, the study considered some low- and higher-cost options to make the airport less vulnerable in the near term. The most cost-effective short-term option is adding employees to check luggage, resulting in faster passenger check-in and faster Transportation Security Administration screening.

This option would require around $1 million in capital costs and $4 million in increased annual operating expenses. It would significantly reduce the size of crowds in public spaces, thus making the airport a less appealing terrorist target and reducing potential casualties should terrorists strike. In fact, increasing the number of check-in and screening workers by just 5 percent could reduce fatalities by 80 percent if terrorists detonated a handheld luggage bomb in a check-in area.

In addition to reducing the density of crowds in the terminals, the researchers concluded that it would be cost-effective to add a permanent vehicle checkpoint program to identify vehicles that might be carrying large bombs. A vehicle screening system might eventually include scales embedded in the roadway to quickly weigh all vehicles entering the airport, allowing officials to identify those that might be weighed down with explosives.

Beyond these two security measures that address vulnerabilities at a relatively low cost, four other measures should be considered for improving airport security. Two would address major vulnerabilities but are relatively expensive: screening all cargo transported in passenger planes and improving the employee selection and clearance procedures. The other two measures—improving perimeter fencing and improving the airport’s rapid-response capability—address less serious vulnerabilities but could be implemented at low cost.

For more information: Near-Term Options for Improving Security at Los Angeles International Airport (RAND/DB-468-1-LAWA).

The most cost-effective short-term option is adding employees to check luggage.

### Potential Bomb Attacks Pose the Greatest and Most Plausible Risks

<table>
<thead>
<tr>
<th>Potential Bomb Attacks</th>
<th>Potential fatalities</th>
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<tbody>
<tr>
<td>Insider-planted bomb</td>
<td>Greater</td>
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<tr>
<td>Uninspected cargo bomb</td>
<td>Greater</td>
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<tr>
<td>Large truck bomb</td>
<td>Greater</td>
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<tr>
<td>Luggage bomb</td>
<td>Greater</td>
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<tr>
<td>Curbside car bomb</td>
<td>Greater</td>
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<tr>
<td>Public grounds attack</td>
<td>Lesser</td>
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<tr>
<td>Air operations attack</td>
<td>Lesser</td>
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<tr>
<td>MANPADS attack</td>
<td>Lesser</td>
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<tr>
<td>Control tower bomb</td>
<td>Lesser</td>
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<tr>
<td>Sniper attack</td>
<td>Lesser</td>
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<tr>
<td>Mortar attack</td>
<td>Lesser</td>
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NOTE: MANPADS = man-portable air defense system (also known as shoulder-fired surface-to-air missile).
Compensation for 9/11 Terror Attacks Tops $38 Billion

In the wake of the 9/11 terrorist attacks, the compensation system provided massive payments to businesses and individuals in New York City. “Losses from the 9/11 attacks induced the largest insurance payments for a single-loss event in U.S. history, unprecedented charitable distributions, and a massive government response,” including the creation of the September 11th Victim Compensation Fund of 2001, noted Lloyd Dixon, a RAND senior economist and lead author of a report that examined the entire 9/11 compensation system.

The study quantified more than $38 billion in benefits across the three compensation mechanisms involved, as shown in the bottom row of the table. Liability caps for the airlines and other potential defendants have limited the role of the tort (or liability) system, at least so far.

The study examined how the benefits were distributed among victim groups. Sixty-one percent of the total quantified benefits (more than $23 billion) went to businesses in New York City, and nearly three-quarters of the benefits received by businesses came from the insurance industry ($17 billion).

Nearly $8.7 billion (23 percent of the total benefits) went to civilians killed or seriously injured. Nearly 70 percent of this sum came from the government. The remaining benefits of roughly $6 billion were spread among the other victim groups.

The insurance industry received praise from key stakeholders interviewed for the study for its quick response and generous interpretation of policies. But some stakeholders noted problems with business-interruption coverage.

The government response varied among agencies. The federal Victim Compensation Fund and the unemployment, Medicare, and Social Security programs were perceived as having responded well. In contrast, the Federal Emergency Management Agency was criticized for being too slow and inflexible, for not coordinating efforts well with charities, and for not addressing long-term emotional injuries from the attacks.

Charities were praised for responding quickly, distributing money quickly, and meeting unmet needs. But charities were criticized for focusing too much on Lower Manhattan, for not coordinating among themselves and government agencies, and for going beyond their traditional roles.

The response to 9/11 was unique and did not establish a blueprint or set of enduring institutions for compensating victims of future large-scale terrorist attacks. Among the key issues that need to be addressed in the future are coordination among different payment sources; the appropriate and respective roles of the government, the insurance industry, charities, and the tort system; and the national security ramifications of different compensation approaches.

For more information: Compensation for Losses from the 9/11 Attacks (RAND/MG-264-ICJ).

### Most of the Quantified Benefits Went to Businesses in New York City

<table>
<thead>
<tr>
<th>Victim Group</th>
<th>Compensation Amount (millions of dollars)</th>
<th>Source of Compensation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civilians killed/seriously injured</td>
<td>8,670</td>
<td>Insurance Industry 23%</td>
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<tr>
<td></td>
<td></td>
<td>Government 69%</td>
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<td></td>
<td></td>
<td>Charity 8%</td>
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<td>Emergency responders killed/seriously injured</td>
<td>1,920</td>
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<td></td>
<td></td>
<td>74%</td>
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<tr>
<td></td>
<td></td>
<td>26%</td>
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<tr>
<td>Businesses</td>
<td>23,330</td>
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<td></td>
<td></td>
<td>27%</td>
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<tr>
<td></td>
<td></td>
<td>&lt;1%</td>
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<tr>
<td>Workers</td>
<td>1,700</td>
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<td></td>
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<td>68%</td>
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<td></td>
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<tr>
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<td>920</td>
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<td>Individuals suffering environmental exposures</td>
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<td>9%</td>
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<td>82%</td>
</tr>
<tr>
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<td>Individuals suffering emotional injuries</td>
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<td>67%</td>
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<td>19%</td>
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<tr>
<td>total</td>
<td>38.1 billion*</td>
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<td></td>
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<td>$15.8 billion</td>
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<td></td>
<td>$2.7 billion</td>
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*$650 million in charitable benefits could not be allocated to any victim group at the time of the study and so are not assigned to any group in the table.
Law Enforcement Agencies Expecting Terrorist Attacks Are Generally Better Prepared

After the 9/11 terrorist attacks, law enforcement agencies bolstered their preparedness efforts, but there is substantial variation in approach and needs among local agencies in small and large metropolitan counties, according to a new report by the RAND Corporation.

The report, based on a nationwide survey of 208 state and local law enforcement agencies that was conducted just prior to the formation of the U.S. Department of Homeland Security, “provides the department with an important benchmark to assess improvements in preparedness and to better target federal funding to the law enforcement community,” said Lois Davis, senior policy researcher and the study’s lead author.

In response to 9/11, state and local law enforcement agencies (particularly those in large counties) undertook a number of steps to improve preparedness for terrorist attacks. Many agencies increased the number of personnel conducting emergency response planning; updated response plans and mutual aid agreements for chemical, biological, and radiological attacks; and increased departmental spending.

But the approach to preparedness has varied by the size of the county. Local law enforcement agencies in large counties have been more engaged in planning and training activities than those in smaller counties.

The flow chart illustrates several findings. Law enforcement agencies that perceive the risk of future terrorist attacks to be higher for their jurisdictions are generally more engaged in terrorism preparedness activities. But perception of risk does not correspond with size of jurisdiction. Even agencies in smaller counties, if they assess the risk to be higher for their jurisdictions, usually improve their levels of preparedness. Perceived risk—not jurisdiction size—is also the better predictor of receipt of federal funding for preparedness activities.

While rural areas are often seen as unlikely terrorism targets, terrorists could strike there because “much of our critical infrastructure and some potential high-value targets, such as nuclear power plants, are located in less populated areas,” Davis said. “Moreover, while preparedness funding has been directed more to populous counties, this study underscores the need for federal and state grant distribution mechanisms to incorporate level of risk into their allocation formulas.”

The study also identified some key support needs to improve response and assessment capabilities, which also varied by county size. “By revealing what local and state law enforcement officials say they need to respond to terrorist attacks more effectively, our study can help state and federal policymakers determine what assistance to provide,” said Davis.


Factors Affecting State and Local Preparedness for Terrorism

“Some potential high-value targets are located in less populated areas.”
A Matter of Class

Educational Achievement Reflects Family Background More Than Ethnicity or Immigration

By Sandraluz Lara-Cinisomo, Anne R. Pebley, Mary E. Vaiana, Elizabeth Maggio, Mark Berends, and Samuel R. Lucas

Sandraluz Lara-Cinisomo is an associate behavioral scientist at RAND. Anne Pebley is a senior research associate at RAND and the Bixby professor of public health and sociology at the University of California, Los Angeles. Mary Vaiana is communications director of RAND Health, a division of the RAND Corporation. Elizabeth Maggio is a communications analyst at RAND. Mark Berends, a RAND consultant, is associate professor of public policy and education at Vanderbilt University. Sam Lucas is associate professor of sociology at the University of California, Berkeley.

We at the RAND Corporation have found that the most important factors associated with the educational achievement of children are not race, ethnicity, or immigrant status. Instead, the most critical factors appear to be socioeconomic ones. These factors include parental education levels, neighborhood poverty, parental occupational status, and family income.

Our findings cannot apply to the entire population of U.S. students engaged in all courses of study at all grade levels. The data do not exist to allow for such a comprehensive analysis. However, we have reached similar conclusions by studying two separate samples of U.S. students: a local, early childhood sample and a national, high school sample.

- In a study of children in 65 Los Angeles neighborhoods, we found that the two factors associated most strongly with school readiness are (1) the educational attainment of mothers and (2) neighborhood poverty. For this reason, school-readiness programs should target children whose mothers are poorly educated and children who live in poor neighborhoods.

- In a study of mathematics achievement among a national sample of high school students, we found that improved socioeconomic conditions among blacks and Latinos correspond strongly to decreases in the mathematics test score gaps—both between blacks and whites and between Latinos and whites. For this reason, socioeconomic policies that benefit lower-income families and communities should be recognized also as educational policies on behalf of the children in these families and communities.

In both cases, we found that education policy for disadvantaged families and communities should not be limited to conventional education policy alone. Current national policy is a case in point. One of the mandates of the federal No Child Left Behind Act is to reduce the educational achievement gaps among students of different races and ethnicities.

Our findings suggest that education policies intended to benefit racial and ethnic minorities can be more successful if policymakers focus less on racial and ethnic factors and more on socioeconomic ones. Education policies alone, when not combined with socioeconomic policies, will be less successful. From preschool to high school, education policies should be coordinated with family and welfare policies—a complex, yet critical interplay that is often ignored by policymakers.
School Readiness: What Matters Most

“School readiness” means that children have acquired the social, mental, and physical skills that prepare them for classroom learning before they start school. Many programs promote school readiness: parenting classes, early childhood intervention programs, early childhood enrichment programs (such as Head Start), public library reading programs, and efforts to improve child-care quality. Evaluations show that effective programs designed to help poor children become ready for school can be very good investments. The question is where to target the resources for the best payoff.

To help answer the question, RAND researchers surveyed families and children in a random sample of 3,010 households in 65 Los Angeles neighborhoods. The researchers also gave standardized math and reading tests to the children and a reading test to the mothers in these families. The survey and tests helped us to assess the correlation between school readiness and two household dimensions: the home literacy environment and parenting behavior.

The home literacy environment consists of the availability of children’s books at home, time spent reading to children, visits to the library, and the amount of television that children watch. Parenting behavior involves disciplinary practices and the degree of warmth that parents show their children.

We found that most young Angelenos have books, are read to regularly, and go to the library regularly. However, many children in poorer neighborhoods and those whose mothers have not completed high school are disadvantaged in terms of reading-related activities. In this respect, Latino children appear to be particularly disadvantaged. They have less access to books at home, are less likely to be read to, and are less likely to use the library regularly. We found that children who are regularly read to and regularly visit the library have significantly higher reading and math scores.

As for parenting behavior, we found that less discipline and greater parental warmth are associated with fewer behavior problems for children, regardless of ethnicity, immigrant status, or neighborhood. Therefore, programs that improve the home literacy environment and improve parenting skills are likely to improve school readiness, even for children from disadvantaged families and neighborhoods.

We examined how the two household dimensions—the home literacy environment and parenting behavior—varied across major Los Angeles social groups. We defined the groups by ethnicity, immigrant status (measured by mother’s place of birth), mother’s educational attainment, and neighborhood poverty. The two characteristics associated most strongly with school readiness turned out to be mother’s educational attainment and neighborhood poverty.

Consistently, the test scores of kids rose with their moms’ education (see Figures 1 and 2). Among moms with a high school education or less, about 30 percent of the kids scored low in reading. But among moms who finished college, nearly all of the kids scored in the high and middle ranges on the reading test. Among moms with a high school education or less, about 40 percent of the kids scored low in math. But among moms who finished college, more than 90 percent of the kids scored in the high and middle ranges on the math test. These findings suggest that children of poorly educated mothers are at a disadvantage and thus are an important target group for school-readiness programs.

Figure 3 shows how strongly a mother’s education influences her children’s reading and math skills when other factors are held constant. Kids whose mothers

School-readiness programs should focus on the children of poorly educated mothers rather than on particular ethnic or immigrant groups.
had at least some college do significantly better than the national average on the reading tests. Kids whose mothers finished college do significantly better in both reading and math. Well-educated mothers, even in poor neighborhoods, are likely to have kids who do well in reading and math.

Mothers’ educational attainment is important even when mothers’ reading scores are held constant. In other words, the link between mothers’ education and children’s scores does not seem to be due entirely to the fact that more-educated mothers can read better themselves. Rather, more-educated mothers may be more likely to understand the importance of learning basic skills early—especially basic skills connected with school. These moms may also be more likely to understand the learning process and how to help their kids develop the skills they need.

On average, Latino and African American children and those who have immigrant parents score lower on reading and math tests than other children. However, we found that the differences in socioeconomic status—particularly in the mother’s education—account for all of the differences in scores that might otherwise be attributed to differences of ethnicity or immigrant status.

In other words, ethnicity and immigrant status themselves are not important predictors of school readiness. In fact, children whose parents were born outside the United States do better on basic skills tests than kids with U.S.-born parents once socioeconomic factors (including mother’s education) are taken into account.

These findings on ethnicity and immigrant status are very important. They suggest that school-readiness programs should focus on the children of poorly educated mothers rather than on particular ethnic or immigrant groups. The findings also suggest that children of all ethnic groups and immigrant statuses can be well prepared for school if they are given the same set of advantages.

With regard to neighborhood poverty, we found that it is a very strong predictor not of basic skills acquisition but rather of behavior problems among young children—problems that impede school readiness. Children in poor neighborhoods are significantly more likely to exhibit both anxious and aggressive behavior, even regardless of parenting behavior. Other factors—ethnicity, mother’s immigrant status, and mother’s education—don’t matter much here, either.

We can only conclude that living in a poor neighborhood may be particularly stressful for young children. Poor neighborhoods may increase the stress levels of parents and older siblings and thus indirectly increase the stress among younger children. Poor neighborhoods may also prevent young children from playing outside or affect the behavior of their playmates.

Policymakers and communities can use these findings to improve school-readiness programs, but the resources are limited. To begin to close the school-readiness gap between advantaged and disadvantaged children, it is important to focus the resources on the children who need them the most. The children most in need appear to be those whose mothers are poorly educated and those who live in poor neighborhoods.
Math Achievement: What Matters Most

With the passage of the federal No Child Left Behind legislation, states and school districts across the country are required to monitor the achievement gaps among students from different socioeconomic, racial, ethnic, and linguistic groups (and between disabled students and other students). So it is important to understand the factors that are related to student test score gaps.

We at RAND focused on the mathematics test score gaps for black and Latino students relative to white students in 1972, 1982, and 1992. We analyzed how changes in family and school conditions corresponded to changes in the test score gaps over time.

We saw significant reductions in both the black-white and Latino-white gaps in math scores. Between 1972 and 1992, the black-white gap narrowed by 20 percent, and the Latino-white gap narrowed by 32 percent (see Figure 4).

We found that the socioeconomic conditions of black students improved relative to white students throughout the two decades of our study. In contrast, the socioeconomic conditions of Latino students improved relative to white students only during the first decade. In both cases, the improving socioeconomic circumstances of blacks and Latinos consistently corresponded to the simultaneous improvements in student achievement relative to whites.

The families of black students made progress relative to the families of white students in all three categories of socioeconomic circumstances that we analyzed: parents’ educational attainment, occupational status, and income. Black mothers had almost one year of education less than white mothers in 1972. But by 1992 this education gap narrowed to about half a year (see Figure 5). Black fathers also made educational gains relative to white fathers.

To gauge trends in occupational status, we relied on the Duncan Socioeconomic Index, which assigns each occupational category a score from 7.22 to 70.21 based on the income and education associated with each occupation. We used the maximum score reported for the father or mother in each family. In 1972, the black-white gap in average occupational status on the Duncan scale was nearly 20 points. But by 1992, the gap contracted to about 9 points (see Figure 6).

To gauge income trends, we tracked the percentage of families whose household incomes fell within the lowest income quintile reported nationally each decade by the U.S. Census Bureau. As shown in Figure 7, the proportion of black students living among the nation’s poorest families decreased dramatically between 1972 and 1992, from 61 percent to 41 percent. The proportion of white students in poor families also decreased, from 30 percent to 19 percent.

Improving socioeconomic circumstances of blacks and Latinos consistently corresponded to improvements in student achievement relative to whites.
Therefore, the percentage of poor families fell by a greater amount among blacks than among whites, meaning that the “poverty gap” shrank. The proportion of black students who still live in poverty is substantial, but the progress of blacks relative to whites is noteworthy. Overall, we found that the combined improvements in socioeconomic measures among black families (including parents’ education, occupation, and income) correlated with a 57-percent decrease in the black-white gap in math scores from 1972 to 1992.

For Latino families, some socioeconomic conditions improved. But the positive trends among Latinos did not allow them to reduce the socioeconomic gap relative to whites, because the conditions among whites improved even more.

Both the mothers and fathers of Latino students had an extra year of schooling in 1992 than in 1972. But white parents made educational gains that were even greater. Likewise, the percentage of Latino students living in poor households fell from 57 percent to 49 percent over the two decades. But the “poverty gap” between Latinos and whites grew slightly (see Figure 7). Only the gap in occupational status shrank between Latino and white households, from about 18 points in 1972 to about 13 points in 1992, using the Duncan scale.

Overall, the socioeconomic conditions of Latino students worsened relative to those of white students, especially during the later decade of 1982 to 1992. In fact, the diverging socioeconomic fortunes for Latinos over this later decade corresponded to a divergence, or net increase, in the Latino-white test score gap during the same time, a sharp departure from the previous decade.

The high schools attended by black and Latino students also experienced long-term trends that corresponded with increasing the gaps in test scores. In particular, these high schools became increasingly populated with higher proportions of minority students from 1972 to 1992.

A high minority composition is often viewed as a proxy for schools that have historically been segregated and underserved by the education system in terms of high-quality resources, services, and instruction. Indeed, we found that the convergence of black-white and Latino-white test scores might have been greater from 1972 to 1992 if the minority composition of the schools attended by the black and Latino students had remained the same as in 1972.

But there was one notably positive change in students’ educational opportunities within schools. In 1972, only 28 percent of black students reported being in the academic track, whereas 41 percent reported such placement in 1992. Among Latino students, only 26 percent reported academic track placement in 1972, compared with 37 percent in 1992. In both years, 47 percent of white students reported academic track placement. We found that the shrinking gaps in academic track placement corresponded to 59 percent of the shrinking gap in black-white test scores and to 34 percent of the shrinking gap in Latino-white test scores.

In sum, the key factors associated with narrowing the gaps in math scores for black and Latino students were (1) improved socioeconomic conditions among their families and (2) expanded placement in academic tracks. The key factor associated with widening the gap for both black and Latino students was the growing minority composition of the schools they attended.

For Latino students, the story is slightly more complex. The socioeconomic conditions of Latino families first improved and then worsened relative to white families, eventually canceling each other out with respect to both family well-being and student test scores. The heavy minority composition of the schools corresponded to a further widening of the Latino-white test score gap. Only the expanded academic track placement among Latino students corresponded with a steady reduction in the test score gap, perhaps allowing the Latinos to make up ground lost elsewhere.
Our findings have several policy implications. Because of the strong correspondence between improved socioeconomic circumstances and decreased gaps in test scores, the particularly worthwhile policies are those that promote socioeconomic progress—educational attainment, occupational advancement, and wage increases—among the parents of black and Latino students.

A key factor in improving the socioeconomic circumstances of future parents is access to higher education today. While there is a great deal of controversy about providing racial preferences for college admission, policymakers need to think about revising affirmative action policies to provide black and Latino students with opportunities for higher education.

Our analyses also show that there were significant advances in achievement for black and Latino students who reported academic track placement. A large portion of the convergences in mathematics scores over time corresponded to the growing percentages of black and Latino students who reported college track placement relative to white students. Therefore, educational policies that require students to take college preparatory courses are likely to further narrow the achievement gap, or at least keep it from widening.

We found that an increasing percentage of minority students were attending high schools with heavy minority concentrations—and that this trend was associated with diverging test scores. Policies that address the increasing racial isolation of students in schools can certainly be controversial. However, recent policy initiatives of some states and school districts to balance school funding across all schools as well as to balance the racial composition of the schools are likely to be worthwhile.

Another worthy policy would be to use socioeconomic measures, such as family income, for admissions purposes in elementary and secondary schools. Such a policy may hold some promise in ameliorating school problems related to poverty. Simultaneously, school districts may be able to use socioeconomic measures to preserve racial and ethnic diversity in schools.

Other educational policies that have gained currency include school choice, vouchers, and charter schools. While choice plans may have some benefit for creating more racially diverse schools, the evidence is far from complete about whether the plans reduce racial isolation across the nation as a whole or whether they contribute directly to closing achievement gaps. As choice plans are developed and implemented under the No Child Left Behind Act, the next few years will be telling in terms of the positive and negative effects of different choice policies.

Beyond any specific policies that may contribute to the closing of the achievement gaps—whether by providing more support to families, increasing educational opportunities, or decreasing racial isolation—it is important to understand that educational policies should be coordinated with socioeconomic policies. If we do not consider how educational policies complement or conflict with policies related to family welfare, work, poverty, housing, and neighborhood conditions, then we will continue to face significant obstacles in attaining our goal to narrow the achievement gaps.

Related Reading


U.S. President George W. Bush has proposed an immense realignment of American military forces around the world. The proposal—to bring home 60,000–70,000 U.S. troops from overseas bases, mostly in Germany and South Korea, and to deploy them as necessary to global trouble spots—is intended as a way to help manage military personnel to meet emerging mission needs.

But military personnel will need to be managed in bold new ways to meet emerging mission needs even without any geographic repositioning of the troops. In fact, the ongoing efforts at military transformation sought by U.S. Secretary of Defense Donald Rumsfeld will require a major rethinking of personnel management and compensation, even extending to a shift in military culture.

For the purposes of military transformation, the most crucial changes in personnel management are not geographic ones. Rather, the military personnel and compensation system must begin to produce greater variation in career paths, to allow for greater flexibility in job assignments, and to place a higher value on innovation, intelligent risk-taking, and entrepreneurship. Four tools can help personnel managers to develop the kind of troops needed for transformation:

- Performance appraisals could place greater emphasis on innovation, creativity, and entrepreneurship.
- Awards could be given to innovators.
- More choice in duty and job assignments could be offered to service members.
- Pay raises without promotions could be offered to service members.

These changes could potentially undercut some of the strengths of the existing personnel system; namely, its visibility, stability, and equity, all of which appear to contribute to high troop morale. The challenge will be to balance the strengths of a new system with those of the old system.

“Transformation” and Its Implications for Personnel

Military transformation can be defined succinctly as follows: a commitment to innovative approaches to war fighting and to supporting war fighters. The overriding purpose is to ensure that the military has the capabilities needed to defend the United States against a spectrum of unknown or uncertain threats, ranging from weapons of mass destruction to attacks on information systems.

The 2001 Quadrennial Defense Review (QDR) outlined a new defense strategy that depends on transformation for success. The strategy represents a shift...
from the Cold War—from focusing on a specified set of threats and planning for two major, simultaneous wars—to focusing instead on the capabilities required to deter and to defend against whatever the threats might be.

Capabilities-based planning recognizes that threats are unknowable beforehand; therefore, it is advantageous to be able to select capabilities from within each service and to combine them into a joint response as needed. Thanks to advances in sensors, communications, situational awareness, precision-guided munitions, and command-and-control technology, U.S. ground, air, and sea forces can now establish a closer working rapport than ever before.

Therefore, transformation requires not only the kinds of high-quality people the military seeks today, but also stronger policies and incentives to promote flexibility, innovation, and well-calculated risk-taking among those people. Future personnel can expect to have very different kinds of careers than those of the past. Likewise, future personnel managers will need innovative and flexible ways to use and to manage personnel. A transformed military will place a premium on adaptability to emergent situations, interoperability, joint operations, rapid responsiveness, agility to capitalize on opportunities in the field, and a small logistics footprint.

All of these priorities will require a change in military culture. The values and beliefs that shape the chain-of-command environment of the military culture today will have to cede some ground to a competing emphasis on innovation and entrepreneurship. Leaders will have a particularly important role in communicating the new values and in rewarding the behavior that conforms to them. Leaders can offer incentives that will promote cultural change.

The values and beliefs that shape military culture today will have to cede some ground.
What's Wrong with the Current System?

The current military compensation and personnel system seems to hamper rather than to encourage the flexible use of personnel. The system produces remarkably similar personnel outcomes, not the kind of variation in military careers required by transformation.

An important example is the military’s promotion process—the key incentive mechanism for high performance. The current process arguably motivates members of the armed forces to perform in a predictable manner that conforms to cultural norms. Most decisionmaking involves risk and uncertainty, but today’s promotion process can make members look bad even for small mistakes or slightly undesired outcomes, perhaps jeopardizing promotions. Thus, the possibility of making even small mistakes can deter informed risk-taking. As long as there is little variance in performance among members and therefore little variance in individual promotion chances, each member has an incentive to “play it safe.”

Frequent rotations worsen the climate of zero tolerance for mistakes. The best way to demonstrate high performance when one’s duty tour is short is to follow the well-worn path of one’s predecessor and conform to past expectations. The lack of lateral entry and the hierarchical chain of command can further exacerbate the conformity problem. Those who become leaders in the chain of command achieve those positions precisely because their performance conforms to expectations.

These factors can lead to a culture of predictability and conformity, not a culture of creativity and innovation. The pressure for predictable and uniform job behavior is embedded within the compensation and personnel system. It is likely to hinder efforts to foster the flexibility, innovation, intelligent risk-taking, and entrepreneurship needed for transformation.

The pay structure itself is inflexible. The current compensation system grants highly similar pay by year of service across all four branches of service (see Figures 1a and 1b). The system produces small variations in experience levels (and thus pay levels) even across occupational areas within the services, with the possible exception of the navy (see Figures 2a and 2b).

The system does result in a high degree of equity in compensation—and indeed equity of opportunity in compensation might be a useful policy in its own right. But it is questionable whether an organization engaged in many different activities and employing many different technologies should find it efficient to have essentially the same mix of pay levels and experience levels in each activity.

In 1999, average cash compensation was around $32,000 for enlisted personnel and $65,000 for officers (see Figures 3a and 3b). Regular military compensation accounted for over 90 percent of these amounts. Numerous special and incentive (S&I) pays do exist. But we cannot tell whether these supplemental pays are being used to promote the best-suited experience mix for producing output or to maintain similarity in experience mix and promotion opportunities.

We do know that the experience mix is quite similar across occupational areas. Ideally, the experience mix required to perform various activities would determine the compensation structure for each activity. But today the opposite is the case: The compensation structure determines the experience mix for performing each activity.
The military retirement system, with vesting and eligibility both kicking in at 20 years of service, creates strong incentives for personnel to remain in the military for 20 years. Despite the advantages of such a system, it can tie the hands of personnel managers. Numerous study groups and commissions that have been convened in the past 55 years to study the military retirement system have concluded that the system stifles personnel management flexibility.

**What’s Right with the Current System?**

Today’s military compensation system was enacted into law in 1949. Although many changes have occurred since then, the core structure—including the basic pay tables, various allowances, supplemental pays, and immediate retirement benefits after 20 years—has remained essentially unchanged.

To its credit, the system accommodates enormous expansions and contractions in force size. It rewards advancement. It offers well-targeted supplemental pays. And it offers valuable incentives both to prolong careers and to exit the force.

The system is highly visible, stable, and equitable. The published, regularly updated basic pay table, coupled with allowances for housing and subsistence, allows members to easily see how their pay will change with longevity and promotion. Changes to the basic pay table are made only after considerable study and deliberation. This stability makes members confident that they can forecast their future earnings. The absence of radical change avoids invidious comparisons and blatant inequities across different generations of personnel (those entering in different years).

That the pay table is common across occupations and services underscores its equity. Different members in different services are equally valued, given their years of experience and rank. A shared awareness of equity may well be a unifying concept in wartime and peacetime. Members see that they are, in large part, paid the same whatever their activity.

The military ranks themselves provide explicit rungs on a career ladder. The opportunity to move up the ranks—and to receive higher pay—represents an incentive structure to induce members to exert effort and to reveal their skills and talents.

The supplemental pays are small in most cases, large in relatively few cases, and typically received by a small fraction of personnel. These pays include sea pay, hazardous duty pay, hostile fire pay, family separation pay, and cost-of-living allowances. Their clear rationale and narrow targeting prevent them from eroding the sense of equity fostered by the basic pay table.

![U.S. Army Lieutenant Shane Aguero holds up material used in making an improvised explosive device and found with a weapons cache stockpiled by the Muqtada militia in Baghdad, Iraq, on Sept. 5.](image-url)
Figure 2a—Small Variations Appear in Experience Levels Among Enlisted Personnel Within the Services

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Years of service:
- 1–5
- 6–10
- 11–20
- 21–30


Note: The U.S. Marine Corps has no health care specialists, but relies instead on the U.S. Navy for health care.
Figure 2b—Small Variations Appear in Experience Levels Among Officers Within the Services

Tactical operations officers
Intelligence officers
Engineering and maintenance officers
Scientists and professionals
Health care officers
Administrators
Supply, procurement, and allied officers

U.S. Army

U.S. Navy

U.S. Marine Corps

U.S. Air Force

NOTE: The U.S. Marine Corps has no health care specialists, but relies instead on the U.S. Navy for health care.
Indeed, one could argue that S&I and other supplemental pays operate to conserve equity, because even though the basic pay table is the same for all personnel, the conditions of work are not the same. Therefore, supplemental pays help to compensate for the differences. By helping to sustain similar retention rates across occupations, supplemental pays also help to maintain similar promotion opportunities across occupations.

The retirement benefit system, with its powerful incentives to stay in the military beyond ten years (when many members might otherwise opt out) and to leave after 20 years, has its advantages. The added retention increases the taxpayers’ economic return to training investments and expands the pool of experienced members whose knowledge of policy and procedure may help keep activities running smoothly.

### Suggested Improvements

We believe that it is possible to create a personnel and compensation system suitable to military transformation without impairing the visibility, stability, or equity of the existing system. But to achieve greater management flexibility and more variable outcomes in career and assignment lengths, there must be a greater cultural demand for flexibility among personnel managers. There must also be incentives for personnel to be innovative and to work in new ways. We propose four changes that could promote transformation while retaining the best of the old system.

1. **Performance appraisals could place greater emphasis on innovation, creativity, and entrepreneurship.** Commanding officers could add these factors to performance criteria and make them figure more prominently in promotion decisions. Expanding the criteria to include transformation-related performance would give members who have the ability to be creative and innovative an incentive to remain in the military and seek advancement to leadership positions.

Although supervisors and commanding officers now appraise personnel performance, a “360-degree appraisal”—whereby subordinates as well as supervisors provide input—might offer additional information about a candidate’s receptivity to ideas from below and efforts to put them into action. Expanded appraisals would not replace more traditional evaluation methods, such as test scores and fitness reports, but would provide supplementary information about dimensions of performance that are either subject to uncertainty or are known to the commanding officer but not easily measured by conventional metrics.

Whenever possible, traditional metrics might be expanded to include measures of performance related to innovation. But a key challenge to implementing a performance appraisal process that recognizes innovation and greater flexibility will be obtaining mean-
ingful metrics and tying specific actions to desired outcomes. For this reason, documentation of initiative should supplement the performance appraisals.

Documentation could include a description of the concept, objective, implementation, and results, such as a quantitative assessment involving not merely case-study descriptions but also before-and-after comparisons of performance relative to that of comparable activities or organizations in the military. In certain cases, comparisons might be extended to the private sector.

When relying on performance appraisals of commanding officers and supervisors, it will be important to beware of “influence behavior.” When performance is difficult to measure or is unmeasured, and when promotion decisions depend heavily on the subjective judgment of supervisors, individuals competing for promotion have an incentive to engage in actions to tout their own talents and accomplishments or to diminish those of their rivals.

The costs of influence behavior can be reduced if subjective evaluations are supplemented with meaningful metrics that are not subject to influence behavior. The costs can be further reduced if the financial gains associated with promotion are limited.

Although limiting the financial gain would also reduce the incentive for high performance, such limits might make sense if the costs of influence behavior are substantial relative to the benefits. Put another way, incentives for high performance might also drive influence behavior, the level of which may be tolerable if the benefits of high performance are large.

2. Awards could be given to innovators. Promotion is only one way to reward desired behavior. Awards can be provided in numerous ways. At present, recruiting commands grant public recognition to outstanding recruiters by means of nonpecuniary awards, such as rings, certificates, and plaques. Such awards and public appreciation could also be given to innovators.

Awards could be given for both individual and unit achievements. Awards could be given based on the attainment of a preset goal, as with recruiting, or based on the judgment of a panel of experts, as with awards for “excellence.” Awards could also be based on a comparison of units with one another, using metrics related to performance level or to performance improvement.

It is crucially important, though, to know what to reward. The prestige of the award depends on well-chosen objectives and a careful selection process with clearly specified criteria.

It is also important to recognize that group-level awards can lead to “free-riding” behavior whereby individuals within the unit reduce effort and rely on colleagues to extend effort. Perverse incentives for free riding can be reduced or at least offset by supplementing awards based on group performance with awards based on individual performance.

Award announcements from top leadership should reinforce the emphasis on innovation, flexibility, and entrepreneurship. This emphasis would help to ensure that people at all levels of the organization take innovation seriously. Reinforcing this emphasis would help to change the military culture by disseminating information about changing values and beliefs.

3. More choice in duty and job assignments could be offered to service members. Permitting a greater degree of choice in assignments would help to build a personnel management system that would be more flexible, more adaptable, and thus more suited to the kind of military culture required for transformation.

Granting more choice in duty and job assignments will require a careful weighing of the benefit to the organization and the benefit to the individual. In
some cases, the organization might have the flexibility to define a set of acceptable assignments, or “capabilities,” and to let individuals choose from within the set. The organization could also establish criteria to define who would be allowed to choose. By taking the organization’s interest into account, the criteria could provide assurance beforehand that the policy of allowing the members some choice would not harm the organization—for example, by resulting in poorer matches between personnel and positions.

On the contrary, the goal would be to reduce the preponderance of rigid, one-size-fits-all “positions” in favor of generating desired, variable capabilities. The goal for personnel managers would be to make superior matches between people and the variable tasks required of them.

An additional benefit would be to increase the members’ level of satisfaction. If members have a say in selecting their assignments, they stand a better chance of getting what they prefer.

A promising example of greater individual choice is the navy’s assignment incentive program. This pilot program is the only program anywhere in the U.S. armed forces that allows people to choose where they go, subject to an online sealed bid auction. The program allows eligible sailors to bid for assignments to distant ports. Sea pay will no longer be included for these billets. Instead, the navy offers to pay a maximum of $450 per month to man the billets.

Because preferences differ among sailors, some will accept a considerably lower amount (by “bidding” to be paid, say, only $250) and yet will be pleased with the assignment. If too few qualified bids are made, the navy retains the right to revert to the current method of making unilateral assignments.

This matching of assignments with individual preferences should result in greater satisfaction and perhaps higher retention than under the traditional assignment system that does not take individual preferences into account. Also, sailors who obtain a preferred assignment might opt to extend their tours, which should reduce the frequency and cost of relocating personnel. Overall, the program should result in mutual benefits to the navy and the individual sailors.

4. Pay raises without promotions could be offered to service members. Pay raises could be offered without promotions to personnel whose grade progression is slower than that of others and who spend more time in a given grade, such as personnel who are on a technical rather than a leadership track. The essential question here is how to link the raises to desired behaviors. The overall objective is to embed tangible incentives for transformation within the personnel system.

One obvious approach would be to pay members based on an assessment of their performance with respect to creativity, innovation, and entrepreneurship. But such an approach would be radical, because it would be a pay-for-performance scheme, as opposed to a pay-by-rank scheme. Today, the military does not use pay for performance at all for individual salaries, except in the sense that superior performance results in faster promotion to a higher rank.

The military offers S&I pays for proficiency in selected skills, for duty in certain locations and circumstances, and for retention. But these pays are designated for a group and go to all members of the group. These pays are either a fixed amount or, in the case of bonuses, an amount that depends on term length. In contrast, pay for performance would offer the same incentive to all members of a group but would pay them according to their performance as individuals.

The simplest and arguably the most positive setting for pay-for-performance schemes is one that has a single, easily measured output, the amount of which depends on an individual’s effort. But the setting in large organizations like the military is typically far more complicated. A unit may report to several offices with different duties, such as readiness and deployability, resource programming, and capital budgeting.

In any case, teamwork is the norm in the military, and attempting to identify and to reward individual contributions may seem arbitrary and divisive. The pitfalls of pay for performance suggest either that it will not see extensive use in the military or that the amount of money at risk and dependent on individual performance will be small.

But while smaller financial rewards imply weaker incentives, even weak incentives can be meaningful.
Informal evidence about military recruiters suggests that their productivity increases when they receive rewards and public recognition for strong performance, even though the monetary value of the rewards is trivial. Evidence about enlistment bonuses also shows that young adults respond to small bonuses. (These rewards and bonuses have been independent of salaries.)

The value of bonuses as a compensation tool lies in the degree of responsiveness and in the ability to target the bonuses to a particular group, thereby limiting the budget outlay. Thus, even if the incentives are weak, pay-for-performance methods should not be dismissed out of hand, especially for some groups of personnel or for those in particular situations.

It’s Up to the Commanders
We have identified a number of changes in personnel and compensation policy that can promote innovation, entrepreneurship, flexibility, and creativity, but whether these changes are pursued will depend on the commitment of top leadership and the demand from within the services at lower levels. A clear, sustained leadership commitment to cultural change is essential for these transformational improvements, especially if the changes appear to run counter to other cultural values such as equity.

Transformation will likely be accelerated if the proposed changes in compensation and personnel policy are proven to be valuable to military capability. To that end, it would be worthwhile to develop, implement, and evaluate a limited number of demonstration projects in the armed forces to test the validity and effectiveness of new personnel and compensation policies. Such demonstrations could focus on specific activities or specific communities where the lessons learned could be leveraged and applied more broadly.

Future analysis should focus on methods of surmounting the obstacles to implementing the new personnel and compensation policies. More information is needed on where the obstacles are the greatest and how to navigate the possible tension between existing cultural values and the introduction of new values. Only by demonstrating the value of change and overcoming the obstacles to it will meaningful change take place and be sustained in the coming years.

Related Reading


Thanks in part to the Green Revolution of the 20th century, the number of people in danger of malnutrition worldwide has decreased significantly in the past 30 years. However, an estimated 800 million people still lack adequate access to food. The world now sits at the cusp of a second agricultural revolution, the “Gene Revolution,” in which modern biotechnology could enable the production of genetically modified (GM) crops that could be tailored to meet the needs of the regions that still face food shortages.

The GM crop movement has the potential to do enormous good, but it may pose potential risks to human health and the environment. We believe that those risks can be controlled at the same time as farm production, rural income, and food security in developing countries are increased.

It is useful to compare the current GM crop movement with the Green Revolution of the 20th century. We compare the scientific and technological differences but focus mostly on the economic, cultural, and political factors. The latter factors are critical in determining whether a new agricultural technology is adopted and accepted by farmers, consumers, and governments. The comparison shows whether and how a Gene Revolution could spread around the world.

 Seeds of Revolution

Historically, agricultural innovations that succeed in becoming agricultural revolutions offer these advantages to farmers, consumers, and governments:

• The new agricultural technologies provide a net financial benefit to farmers.
• The movements substantially improve agricultural production, food nutrition, or both. Or the movements substantially decrease the necessary inputs, such as fertilizer or water.
• People are generally willing to adapt culturally and economically to the new technologies. Consumers accept the products of the agricultural movement.
• There is cooperation among those who provide, regulate, and use the technologies.
• The movements are sustainable, eventually requiring no public subsidies.

The Green Revolution began in the 1940s, reached its peak in the 1970s, and continues to affect agricultural practices today. It has staved off massive malnutrition, transformed agriculture, and increased food production in Asia, Latin America, and even parts of the industrialized world, such as Great Britain. But in Africa, where the Green Revolution arrived later, it has yet to improve food production in a sustainable way.

In contrast, the Gene Revolution could be considered revolutionary so far in only four countries: the United States, Canada, China, and Argentina. Certain
GM crops, such as soybeans, corn, and cotton, now constitute from about 30 to 80 percent of total plantings of these crops in those countries. The benefits provided to growers mean that the GM varieties will likely continue to be a substantial portion of total future plantings. Adoption of the GM crops has led to increased yield, decreased use of pesticides or particularly harmful herbicides, and, in some cases, improved food quality. Policymakers and most of the general public in these countries accept the new technology.

But the Gene Revolution has stalled on the global stage. Consumer and environmental concerns, along with precautionary regulations, have limited its spread to countries that could benefit from it the most, notably much of sub-Saharan Africa, where famine continually threatens the population (see the figure). It is illuminating to compare the Gene Revolution with the Green Revolution in four areas: science and technology, funding, geographic reach, and policies and politics.

Science and Technology
The Green Revolution brought scientists and farmers together. Scientists integrated their research with traditional farming practices to tackle problems that were constraining crop yield. High-yield seeds for rice, wheat, and corn were introduced in parts of the world where those crops made up a large portion of the daily diet. Pesticides, chemical fertilizers, and irrigation systems were introduced to aid the farmers in controlling pests, treating low-quality soil, and delivering water.

The Gene Revolution allows previously unheard-of combinations of genetic traits across species to achieve prespecified objectives. For example, daffodil and bacterial genes can be introduced into the rice genome so that rice produces beta-carotene, the precursor of vitamin A. The benefits of current GM crop varieties include increased yield, reduced pesticide and fertilizer use, reduced vulnerability to the whims of nature, and improved nutritional content. Other GM crops are now being developed to survive on less water, to survive in soil heavy in salt or metals, to convert nitrogen from the air, and to produce vaccines against diseases such as cholera and hepatitis B.

One challenge that did not arise during the Green Revolution but that is fundamental to the Gene Revolution is the issue of intellectual property (IP). Science and technology advance through the sharing of ideas and resources, but IP ambiguities and restrictions can often limit this diffusion. Commercial application of biotechnology has taken place primarily through the private sector in the United States. The issue of who "owns" a particular "event" (the successful modification of a genetically modified crop) and who can develop the crop further has become so economically important and contentious that numerous cases involving this issue are being litigated.

Funding
Philanthropic organizations provided the seed money for the Green Revolution. Initial funding came from the Rockefeller Foundation. Later, other foundations and governments in countries where the efforts were taking place, such as in Mexico and India, joined the effort, as did international organizations.

Then in 1971, while the Green Revolution was bearing its first fruits in many parts of the world, orga-
nizations in industrial countries pooled their resources and formed the Consultative Group on International Agricultural Research (CGIAR). The funding sources for research on agriculture in the developing world thus came to include European nations, Canada, and Japan. The work of CGIAR spread to more than 100 countries, sponsoring research on all key crops in the developing world and also on livestock, fish, forestry, plant genetics, and food policy.

Today, some 50 donors provide expanded funding in association with CGIAR. The newer donors include the World Bank, the Food and Agriculture Organization of the United Nations, the U.S. Agency for International Development, and other public organizations.

In contrast, genetically modified crops are largely the products of private industry. Successful companies serve their markets with the intent of generating profits. With regard to agricultural biotechnology, therefore, companies in the United States and elsewhere have for the most part created seeds that farmers can and will purchase primarily in industrialized countries: corn and soybeans that can tolerate a particular herbicide, corn and cotton that are resistant to particular pests, and food crops that last longer on the supermarket shelf.

Indeed, the GM seeds are designed for the particular planting situations in industrial countries. The targeted farmers have generally found it worthwhile to buy the seeds. In industrialized nations, therefore, GM crop technology has had the potential to revolutionize farming.

But the current GM seed varieties are neither affordable nor useful to most of the world’s poorer farmers. Hence, the revolutionary impact has been limited in the developing world. There seems to be a mismatch between technology and need, driven by the funding sources of basic research.

**Geographic Reach**

The Green Revolution has achieved substantial agricultural production increases in Mexico, the rest of Latin America, India, and Southeast Asia but not in most of Africa. There are two prominent explanations. One is that the technology package—crop breeding, fertilizers, pesticides, and irrigation—that was so helpful elsewhere was unsuited to African crops or growing conditions. The other is that African transportation systems were ill designed to deliver either the technology package or its resulting products.

In contrast, the key technology package of the Gene Revolution is simply the improved seed. Therefore, all farmers should be able to take advantage of the Gene Revolution if they can pay for the seed. But an important geographical constraint is the set of cultural factors that might deter farmers from embracing the new science. Genetically modified crops have already become a stigmatized technology in some parts of the world because of concerns about manipulating organisms in seemingly “unnatural” ways and because of fears of the unintended adverse effects on human health and the environment.

**Policies and Politics**

At the time that the Green Revolution technologies were being developed in the 1940s and 1950s, the United States and the rest of the industrialized world feared that food crises in developing countries would foment political instability that could push those countries toward Communist regimes. Partly as a result of Cold War priorities, the U.S. government was highly concerned about agricultural science in the developing world and worked with nonprofit foundations and scientists in the post–World War II decades to bring about the Green Revolution in the regions subject to
famine. The Green Revolution owed much of its success to public-sector institutions that poured resources into the effort. Policymakers saw a political need for agricultural improvement worldwide, advanced this cause as a key policy concern, and ensured that funds were appropriated toward the cause.

Compare this with the current Gene Revolution: Biotech industries created genetically modified crops, and governmental agencies have seen fit to regulate the crops to prevent or to mitigate potential health and environmental risks. Today, there does not appear to be a strong political motivation for genetically modified crops to succeed in the developing world. Communism is no longer a threat; and famines, while still a problem, appear to be more the result of local weather, politics, and wars than the portent of any sweeping geopolitical threat. Instead, the driving forces determining whether GM crops are adopted in various parts of the world are now health and environmental concerns and national and international regulations, notably the battle between U.S. and European Union regulations.

Lessons from the Green Revolution for the Gene Revolution

The similarities and differences between the Green and Gene Revolutions lead us to several conclusions. For the GM crop movement to have the sort of beneficial global impact that would constitute an agricultural revolution, the following conditions must be met.

1. **Agricultural biotechnology must be tailored to, and made affordable for, farmers in the developing world.** Otherwise, farmers may not see that it is in their best interest to use GM crops despite the unique benefits the crops could provide.

2. **There is a need for larger investments in research in the public sector.** Numerous studies have shown the importance of public-sector research and development in aiding agricultural advancements. Partnerships between the public and private sectors can result in more efficient production of GM crops that are useful to the developing world and can expand the accessibility of those crops and their associated technologies to developing-world farmers.

3. **Agricultural development must once again be regarded as critically important from a policy perspective in both donor and recipient nations.** As world population numbers continue to climb, agricultural development remains necessary for eliminating malnutrition and preventing famine, particularly in sub-Saharan Africa. Many see GM crops as a means to address these problems, but policymakers worldwide are far from being a combined force on this issue.

4. **Policymakers in the developing world must set regulatory standards that take into consideration the risks as well as the benefits of foods derived from GM crops.** Any health, environmental, or socioeconomic disruptions from a new agricultural revolution will fall under public scrutiny. Regulatory standards will be crucial in gaining the cooperation of the many stakeholders involved and in sustaining the GM crop movement. Without regulations that explicitly take into account the potential risks to farmers and consumers, the nations that stand to benefit the most from GM crops might discourage them from being planted.

The Gene Revolution must overcome an intertwined collection of challenges before it can have an impact beyond those regions of the world that already produce excesses of food. If the GM crop movement can overcome these challenges while proving itself to be acceptably free of adverse health and environmental consequences, it has the potential to provide benefits to farmers and consumers around the globe in previously inconceivable ways as well as to mitigate the need for potentially harmful chemicals or scarce water supplies.

Related Reading

Compensation Against Terrorist Attacks
National Security Adds a New Policy Dimension

By Lloyd Dixon and Robert Reville
Lloyd Dixon is a senior economist at RAND. Robert Reville is director of the RAND Institute for Civil Justice, a unit of the RAND Corporation.

In the wake of the devastating hurricanes that struck Florida, the nation’s compensation system kicked into high gear. Relief began flowing to individuals and businesses, much as it did in the aftermath of the 9/11 terrorist attacks. But while the players are the same—insurance companies, government agencies, the lawyers and courts of the tort system, and charities—the compensation issues for hurricanes and terrorist attacks, while similar in many respects, are fundamentally different in others.

During any disaster, the compensation system must deal with economic efficiency issues, for example, by providing incentives and the means to put idle assets and people back to work after a disaster. And in any disaster, the system must also deal with equity issues, whether by paying benefits to individuals and businesses that mirror their actual losses or by determining how benefits are distributed among possible claimants.

But unique to foreign terrorist attacks on our soil are issues of national security. The frequency and strength of hurricanes (or, for that matter, any natural disaster) are not affected by what we do to protect ourselves against them and recover from them. Not so with terrorists like al Qaeda, whose key goals are to induce panic, social fragmentation, uncertainty, and economic ripple effects. To the extent that the compensation policies we choose reduce those consequences, the policies will reduce the impact of terrorist attacks and, thus, may reduce the perceived payoffs to terrorists of carrying them out.

The policies we choose can make us more vulnerable to such attacks. In some cases, businesses may underprotect their assets. For example, a chemical plant may fail to secure dangerous chemicals from terrorists as thoroughly as society might desire because terrorists may be unlikely to use the chemicals against the plant itself. In such cases, it may make sense to provide adequate incentives for businesses to protect their assets by, say, having the government require minimum security measures.

In other cases, firms may go to the other extreme and overprotect their assets. As noted by RAND colleague Darius Lakdawalla, a business may decide to locate to a less urban area to reduce its exposure to terrorism. While such a response may make perfect sense for the firm, the remaining firms may face an increased risk of attack as a result. In these cases, it may make more sense to discourage businesses from investing in overly costly prevention measures or adopting socially undesirable avoidance measures by having the government subsidize terrorism insurance to cover potential losses.

While compensation systems must always deal with trade-offs between economic efficiency and equity, those trade-offs become more complicated when national security concerns enter the mix. For example, focusing on national security may result in lower economic growth if productive assets (such as high-rise buildings in New York City) are not built. Then again, compensation systems that focus on economic revitalization (for example, by encouraging large numbers of businesses and residents to return or relocate to Lower Manhattan) may have adverse national security ramifications by creating a target for terrorists.

National security concerns have not played a prominent role in developing or modifying policies on compensation and assistance in response to terrorism. Unfortunately, such thinking is only in the beginning stages. But as the nation begins to consider what to do next with its terrorism compensation policies—such as the Terrorism Risk Insurance Act of 2002 that expires in 2005—it is critical that the national security factors be acknowledged in the debate.
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