IDA Annual Report 2008

The Institute for Defense Analyses is a non-profit corporation that administers three federally funded research and development centers to provide objective analyses of national security issues, particularly those requiring scientific and technical expertise, and conduct related research on other national challenges.

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Message from the President

It is my privilege to succeed Larry Welch as president of IDA. The quality of this institution and its products owes much to General Welch's leadership over the last two decades – and to the high-caliber staff that he and the Division and Center Directors recruited. People are the heart of any institution, and IDA is fortunate to have such an intellectually skilled and highly motivated team.

This report documents the contributions that team made in 2008 to IDA's mission: "addressing important national security issues, particularly those requiring scientific and technical expertise." In his January 2009 Foreign Affairs article, the Secretary of Defense called on the national security community to "reprogram…the Pentagon for a new age." He followed with a budget proposal that seeks balance between the present and the future, between counterinsurgency capabilities and more conventional capacities, and between retaining successful institutional traits while shedding the unproductive.

IDA's work this last year supports the Secretary's broad goals. At IDA's Studies and Analyses Center, for example, our researchers are deeply engaged in operational testing of the Mine Resistant Ambush Protected vehicles so critical to protecting U.S. troops, and in the broad pursuit of technologies for countering the improvised explosive devices that threaten them. IDA staff contributed to improving the use of biometric technologies in Iraq and Afghanistan, and to developing better protection against the classic threat of chemical munitions. We provided the congressionally-mandated independent assessment of the proposed deployment of ballistic missile defenses in Europe against a potential Iranian attack. IDA assists the Director of National Intelligence in assessing risks to the Intelligence Community's supply chain resulting from a "globalized" economy, and its information technology specialists advise a wide range of sponsors on the challenges of cyber space, including how to build, operate, and protect complex networked systems to meet their needs. IDA analysts supported the Tenth Quadrennial Review of Military Compensation, as the Department of Defense sought to balance sustaining the success of the All-Volunteer Force with the budget burden of sharply increased operating costs.

At IDA's Communications and Computing Center, our researchers continue to produce cutting-edge products in mathematics and computer science for the National Security Agency. IDA also brings its science and technology expertise to bear on problems faced by other federal agencies, often through its Science and Technology Policy Institute. Among its several projects of note this last year is one supporting the President's Council of Advisors on Science and Technology, as the Council sought to move the goal of "personalized medicine" closer to reality.

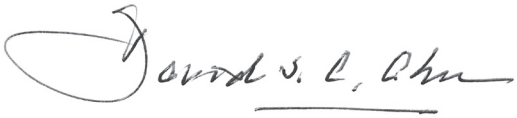
Dr. David S.C. Chu, President

Because the volume of IDA's work for DoD is constrained by statute, IDA and its research sponsors work together to ensure that its capabilities are applied to the most analytically challenging problems facing the Department. I hope you will agree that we met that standard in the work described in this report, and that IDA's multidisciplinary approach provided the insights needed to address the issues posed by our sponsors. Whatever immediate issues must be confronted, however, the ultimate standard for these analyses is their ability to identify underlying phenomena – "root causes" if you will. In doing so, there is no substitute for bringing the tools of all disciplines to bear, in a research culture that prizes vigorous intellectual debate and a close, collaborative dialogue with the sponsoring communities.

We hope this report will convey, at least in part, a sense of the analytic depth and diversity of IDA and its staff. Each of the sections dealing with the research of our three FFRDCs opens with a discussion of overall research capabilities and, except when limited by classification, then describes in some detail one of the significant tasks highlighted above.

I believe IDA's exceptional analytic talent, can-do culture, close working relations with sponsors, and attention to efficient operations provide a solid foundation for sustaining the institution's contributions to national security, broadly defined. We at IDA look forward to the analysis of future issues every bit as challenging as those described in this report. Our research sponsors can count on our willingness to address them with the independence and rigor they deserve.

Dr. David S.C. Chu



President, IDA

Studies and Analyses Center

The Studies and Analyses Center (SAC) is the largest and oldest of IDA's three federally funded research and development centers. Located in Alexandria, Virginia, it consists of eight research divisions:

- Cost Analysis and Research Division
- Information Technology and Systems Division
- Intelligence Analyses Division
- Joint Advanced Warfighting Division
- Operational Evaluation Division
- Science and Technology Division
- Strategy, Forces and Resources Division
- System Evaluation Division

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In 2008, IDA provided strategic advice on more than 300 topics to sponsors in a variety of offices within the Office of the Secretary of Defense, the Joint Staff, Combatant Commands, and Defense agencies. It also conducted studies for other government agencies, including the Department of Homeland Security, the Office of the Director of National Intelligence, the National Aeronautics and Space Administration, the Federal Bureau of Investigation, and the Department of Veterans Affairs.

The breadth of the SAC's research reflects the diversity and depth of IDA's technical and scientific expertise, which rests on the academic training and professional experience of its nearly 700 research, professional, and support staff members. This enables IDA to produce work that varies from quick-reaction studies, completed in a handful of weeks, to multi-year projects.

Major research program areas include:

- Providing independent reviews of test and evaluation programs.
- Assessing joint force strategy, capabilities, operations, and plans.
- Improving the federal government's capabilities to estimate costs.
- Evaluating technologies for advanced applications.
- Assessing technology issues in support of the acquisition process.
- Developing better analytic tools for examining defense issues.
- Streamlining DoD and other agency management systems, processes, and support.


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EVALUATION
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COMMUNICATIONS
PLANNING
SUPPORT
PROJECTS
CENTER
STRATEGY
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Cost Analysis and Research Division

The Cost Analysis and Research Division (CARD), as the name indicates, engages in both cost analysis and applied research on a broad set of topics involving resource allocation within DoD and other federal agencies. Most CARD projects are intended to support and improve government decision-making, policies, or processes.

Analyzing Costs in Support of Government Decision-Making

The cost analyses conducted by CARD researchers are often focused on pending decisions. For example, we estimated the likely cost of a new target aircraft for use in testing. This aircraft was to be derived from a commercial aircraft and to be produced using commercial methods. The underlying issue was whether it would be advantageous for DoD to develop such a target aircraft. Much of CARD's manpower work also has this flavor. In the past year, we completed a study of whether it would be more cost effective to achieve the required number of mid-career Navy surface warfare officers using retention bonuses (and lower accessions) or higher accessions (and lower or no retention bonuses). CARD researchers have also undertaken business case analyses in support of government decisions. One recent example was a study of whether it would be beneficial for the Department of Energy to consolidate certain facilities of the Sandia National Laboratories site in California within contiguous facilities of the Lawrence Livermore National Laboratory.

Examining Resource Allocation Policies

Sponsors frequently ask CARD researchers to analyze policies bearing on resource allocation issues. These policies guide resource allocation decisions but are one step removed from particular decisions themselves. A recent example of work in this area was our analysis of the extent to which the existing tools of DoD profit policy can be used to incentivize better contract outcomes in terms of system performance, cost, and delivery time. In another study, we analyzed the extent to which consolidating ship builders, which DoD encouraged in the mid-1990s, had succeeded in reducing infrastructure cost, the original DoD goal. Our work on training transformation helped DoD's leadership assess the effectiveness of training to support operational missions. And we have examined the effectiveness of various aspects of DoD's efforts broadly to transform how the military services and Combatant Commands conduct joint training, both for individuals and units.

Improving Resource Allocation Processes

CARD efforts in this area examine the efficiency and effectiveness of the processes used in allocating resources. Studies in this category are particularly challenging because they require not only extensive knowledge about existing processes and the sponsor's

role in relationship to other stakeholders, but they also demand a solid grasp of what sort of alternatives are feasible and the ability to analyze their likely consequences. Our innovative work in support of the Quadrennial Review of Military Compensation (QRMC), described in the section below, is an example. We have also helped develop architectures for the data used in reviews of Major Defense Acquisition Programs and in the annual review of DoD programs conducted by the Office of the Secretary of Defense.

Overall, CARD analyses tend to be quantitative, focus on resource allocation issues, and cover a wide range of specific topics – manpower, medical, costing of major systems, acquisition policy, and data architectures, among others. Also, CARD researchers often participate in studies conducted by other IDA divisions, providing cost estimates in support of analyses of alternatives and other assessments of the cost-effectiveness of major government programs.

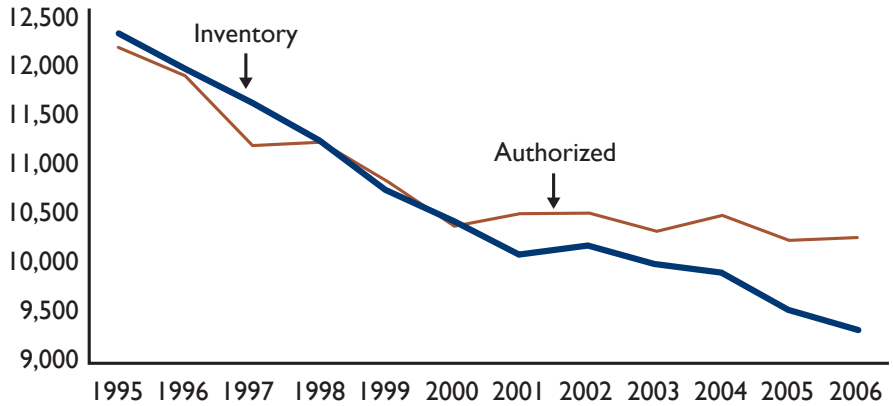
Highlighted Study

Support for the Tenth Quadrennial Review of Military Compensation

As required by statute, every four years DoD reviews the principles and concepts of the compensation system for members of the uniformed services. IDA was asked to support the efforts of the Tenth QRMC to "identify approaches to balance military pay and benefits in sustaining recruitment and retention of high-quality people, as well as a cost-effective and ready military force."

CARD researchers examined nine issues addressing a wide range of policy areas, including pay for performance, the introduction of certification pay, greater use of flexible benefits and vouchers to allow personnel to tailor their own compensation packages, greater use of auctions in setting compensation levels, and

CARD Examined Decreasing Active-Duty Nurse Inventories



CARD found that a decreasing supply of nurses is hampering efforts to meet nurse staffing goals. It recommended expanding the recruitment pool to include registered nurses with associate degrees and creating programs for these nurses to complete their bachelors of science degrees in nursing.

QRMC Team


Dr. Gregory A. Davis


Dr. Lawrence Goldberg


Mr. Stanley Horowitz


Ms. Maggie X. Li


Dr. Philip M. Lurie


Dr. Susan L. Rose


Mr. David Tran


Dr. Karen W. Tyson

improving management of housing allowances.

Two analyses focused on DoD medical care. The first examined ways to improve the recruitment and retention of military medical professionals. The second analyzed the cost of providing medical care to military retirees and dependents.

Since 2000, DoD has had shortages of nurses, and by 2006, 8 percent of authorized Nurse Corps billets were unfilled. The services have been recruiting only nurses with bachelor's degrees, even though most employed nurses in the United States lack a four-year college degree. We found no evidence to indicate that the quality of care and leadership provided by nurses without bachelor's degrees is significantly different from that provided by those with degrees. In addition non-degree nurses are admitted to the Reserves but not to the active-duty force. IDA recommended that DoD draw on the population of non-degree nurses to help fill its active-duty shortage.

As a result the QRMC recommended that, "The services expand their recruiting pool to include registered nurses with associate degrees and create a program for these nurses to complete their Bachelor of Science in Nursing degrees."

The cost of providing medical care to active-duty and retiree families rose 87 percent between 2001 and 2008. Mostly this was due to retiree families dropping private health insurance and returning to the military health care system (TRICARE), which offers HMO (Prime) and non-HMO (Standard/Extra) options. The reason retirees dropped private insurance and returned to TRICARE was the increase in relative costs.

Between 2000 and 2006, the cost of private insurance to retirees rose by almost 40 percent in constant dollars. By contrast, TRICARE costs to retirees fell by a third, in part because they were not indexed for inflation. Because of this, 22 percent of retirees dropped private health insurance and moved to TRICARE over this period.

We analyzed two policies for lowering TRICARE costs and found neither to be cost-effective. The first involved using subsidies to encourage current TRICARE members to move to private health insurance. We concluded that few TRICARE families would switch to private insurance, and the savings from their lower utilization would be overtaken by subsidy payments to those who already have private insurance. The second option involved paying a subsidy to induce movement into a high-deductible health plan that reduces TRICARE utilization. Here, we found that payments to those with little or no utilization would greatly exceed savings from those with high utilization.

IDA found that one way to reduce TRICARE costs to DoD would be to increase modestly TRICARE premiums and out-of-pocket expenses. For example, increasing subscriber premiums by $500 and out-of-pocket costs by 10 percent would save the government over $1 billion per year.

As a result the QRMC recommended that retirees under 65 "pay premiums that cover a larger portion of their actual health care costs and that are adjusted to reflect health care cost increases."

Information Technology and Systems Division

Researchers in the Information Technology and Systems Division (ITSD) are focused on helping sponsors improve operations in, through, and from cyberspace. ITSD analysts develop strategies, perform technology assessments, and evaluate information environments to identify and help eliminate vulnerabilities. They seek to strengthen sponsor operational advantages through a combination of organization, policy, and technology.

Recently, ITSD work has included:

- Developing architectures and associated plans for the transition from many stove-piped enclaves to an internet-sized environment that supports assured information sharing on demand for all authorized users;
- Analyzing IT supply chain vulnerabilities and recommending courses of action;
- Creating the policy framework for a secure defense industrial base;
- Developing distributed command and control constructs for computer network defense; and
- Analyzing and recommending approaches to organizing for effective cyberspace operations.

Our tasks illustrate the breadth of expertise required to work in this challenging, fast-paced area. In 2008, ITSD researchers helped develop architectures and pilot IT capabilities to move from isolated, stand-alone IT systems and platforms, built with a high percentage of custom hardware, to a secure, robust information environment that extensively leverages commercial products.

Building on past efforts, we provided an updated analysis of IT supply chain components and processes; identified potential areas of concern; and suggested policy, organizational, and technical approaches for mitigating vulnerabilities.

We also continued to support DoD's efforts to strengthen security and improve understanding of the risks to the IT networks operated by firms in the defense industrial base. ITSD researchers worked with sponsors and their industrial partners to develop a policy framework to strengthen security across the collective IT environment, including enhanced reporting of network intrusions at industrial firms.

Unlike air, land, and sea environments, cyberspace is a constructed domain, and operating that domain is a necessary starting point. To facilitate defense of this domain, IDA researchers piloted a virtual approach to command and control

for computer network defense. Separately, IDA researchers performed assessments of existing DoD cyberspace organizational constructs, developed alternatives, and provided specific recommendations to enhance operations.

ITSD is supporting DoD, the Director of National Intelligence (DNI), and other federal government sponsors on a variety of other tasks, including:

- Advising DoD and DNI on the organizational and policy issues they might encounter as they attempt to implement enterprise solutions for data sharing, enterprise services, and common processes;
- Devising secure architectures and specific IT solutions based on commercial off-the-shelf solutions to support migration of IT enclaves towards assured enterprise information sharing in an Internet-sized environment;
- Developing command and control constructs, organizational and technical approaches to support the cyber mission; and
- Recommending policies and processes to improve trust in the hardware and software used in the IT supply chain.

Highlighted Study

Service-Oriented Architecture Testing

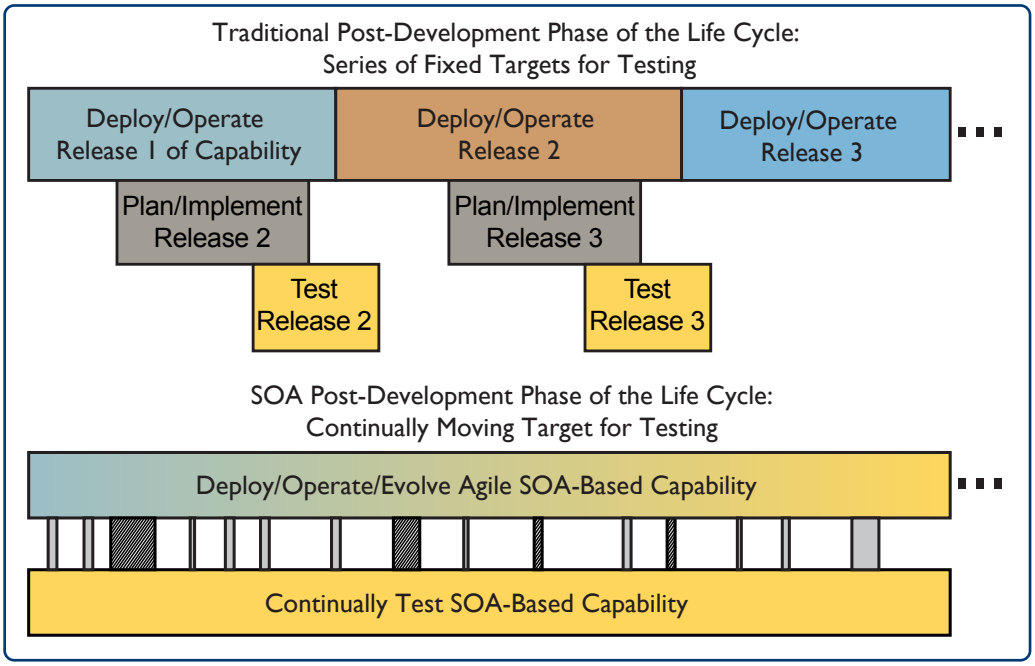
Service-oriented architecture (SOA), a foundational element of the DoD net-centric environment, revolutionizes software development. With SOA, software-based mission capabilities are no longer constructed as monolithic entities, but as compositions of loosely coupled software components, referred to as "services," that communicate via messages. These services can be shared across organizational boundaries.

In a mature, service-rich environment, SOA enables agile capability development and evolution, through the reuse of shared services and the compositional, or "building-block," approach to development. Agility, arguably the greatest SOA benefit, nonetheless presents major testing challenges. IDA researchers investigated these and other SOA testing challenges. We also surveyed the capabilities of commercial SOA testing tools.

We concluded that encouraging developments are taking place within the commercial SOA testing marketplace. Vendors are offering a wide range of tools that are beginning to address several of the SOA testing challenges. The tools apply to all phases of the software life cycle, from early development through operations and support. The vendors are also recognizing the vital role of governance in the cross-organizational, shared SOA environment.

However, our researchers also found that the business-application focus and limited scale of many of the commercial SOA testing tools represent potential shortfalls with

Testing Requirements for SOA-Based Capabilities Fundamentally Differ from Those of Traditional Systems



respect to DoD needs. The Department's needs are larger in scope and more complex than those of typical business customers; moreover, DoD has less well understood applications with more challenging requirements.

Finally, IDA researchers determined that SOA-based capability development, evolution, and testing must take place within the context of sound SOA governance, which is essential if order is to be maintained in a cross-organizational environment characterized by sharing and agility. We offered suggestions to improve existing governance approaches.

Contrasting SOA and Traditional Systems

IDA researchers concluded that SOA-based capabilities have testing requirements that are fundamentally different from those of traditional capabilities. For example, in the post-deployment phase of the life cycle, traditional capabilities require testing at times of transition from one release of the capability to the next (upper figure, above), whereas SOA-based capabilities require continual testing (lower figure, above). This difference is due to the following features of SOA, which can lead to frequent and potentially unanticipated changes:

Agile capability evolution. Changes (light gray) can readily be made to an SOA-based capability by its owning organization in response to changing opportunities and threats. In addition, if a capability uses a shared service owned by another organization, then the other organization can – subject to governance restriction – make changes (dark gray) to the capability via the shared service.

Agile runtime configurations. Moreover, SOA-based capabilities operate in a dynamic environment. They adapt to changing operational conditions, such as network congestion and overloaded services, by using dynamic routing and dynamic binding.

As noted by IDA, enhanced testing must be coupled with sound governance, which imposes discipline on the SOA environment by, for example, placing constraints on the changes that can be made to shared services.

SOA Testing Team

Dr. Karen D. Gordon

Mr. William T. Mayfield

Intelligence Analyses Division

In 2008, its first year of operation, the Intelligence Analyses Division (IAD) established a record of providing high-quality analyses across the Department of Defense and the wider Intelligence Community. IAD researchers conducted analyses in support of DoD's Under Secretaries for Intelligence and Policy, the Joint Staff, the Pacific Command, the Defense Intelligence Agency, the National Geospatial Intelligence Agency, and the Joint Improvised Explosive Device Defeat Organization. In addition, the division conducted studies for several offices reporting to the Director of National Intelligence.

The IAD research staff is composed of experts with advanced degrees in mathematics, physics, economics, military history, engineering and business administration, virtually all of whom have experience working on intelligence issues. In addition, many IAD researchers have combat, combat support, and law enforcement experience.

The division is housed within an expanded specially compartmented intelligence facility at IDA's headquarters in Alexandria, with access to information technology systems and data appropriate to conduct the sensitive work of IDA's sponsors.

In 2008, IAD work included analyses of applications for tagging-,tracking-, and locating-systems, the financing of terrorist organizations; Asian counterterrorism; worldwide improvised explosive device developments; measurement and signals intelligence applications, surprise technologies, cyberspace operations, National Military Command Center transformation, and acquisition risk assessments.

Highlighted Study

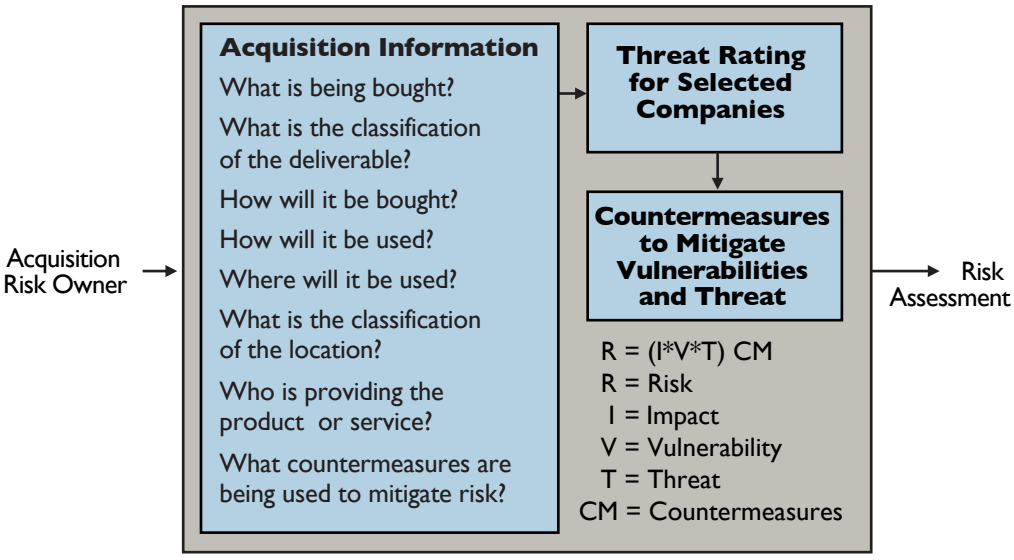
Assessing Risk in the Intelligence Community Supply Chain

Since 2006, IDA has been supporting the Community Acquisitions Risk Section (CARS) and its predecessor organization. CARS is part of the National Counterintelligence Executive, a component of the Office of the Director of National Intelligence. Its mission is to protect against attempts by foreign intelligence entities or terrorists to exploit the supply chain for Intelligence Community acquisitions in order to damage U.S. intelligence interests.

IDA was asked to assist in analyzing counterintelligence and security threats to Intelligence Community acquisitions. This work includes assessing potential threats posed by foreign ownership of, control over, or influence on private sector companies with which the Intelligence Community seeks to do business. Because of the sensitivity of these assessments, it is essential the work be conducted by an organization like IDA that has no potential conflicts of interest involving the companies being examined or their competitors. In carrying out this work, IDA has:

- Conducted several hundred threat assessments of companies, some of which revealed a specific potential threat from an intelligence entity;
- Supported the development of a revised risk assessment analytic tool;
- Supported the deployment of that tool to all components of the Intelligence Community; and
- Contributed to the development of a training program for new CARS threat analysts.

IAD's Intelligence Community Acquisition Risk Methodology



IDA advised CARS on risk mitigation and assessment strategies, using methodologies like this one, that determine the potential threats posed by foreign ownership of companies that work with the Intelligence Community.

Supply Chain Risk Team


Ms. Tara E. Bauman


Ms. Deborah L. Best


Ms. Patricia A. Cohen


Ms. Angela L. Hart


Dr. Harvey E. Heiges


Ms. Betty Rosewell

At the end of 2008, IDA was asked to expand its supply chain efforts to include evaluating projects undertaken by the new Intelligence Advanced Research Projects Activity (IARPA), the first such activity outside CARS itself. In this role, IAD is:

- Advising IARPA on strategies for including risk assessments in the evaluation and selection of new cutting-edge research projects;
- Assessing potential risks of foreign intelligence involvement with those organizations submitting proposals to IARPA;
- Advising on the establishment of risk mitigation measures for future research programs; and
- Providing insights into program security needs and ways to minimize intelligence vulnerabilities.

In addition, because of our ability to conduct supply chain risk assessments and threat evaluations, and because of our knowledge of associated analytic methodologies and oversight processes, DoD also turned to IAD for assistance in developing a new acquisitions risk center supporting the Department. We are now examining implementation strategies for the center and developing training procedures for threat analysts.

Joint Advanced Warfighting Division

The Joint Advanced Warfighting Division (JAWD) includes three programs:

- The DoD-chartered Joint Advanced Warfighting Program (JAWP) serves as a catalyst for stimulating breakthrough improvements in joint military capabilities. The JAWP team is composed of military personnel on joint assignments (three from each military service) and civilian analysts.
- An IDA Simulation Center, established to develop and apply advanced modeling and simulation techniques to address national security issues.
- The IDA Combatant Command Support Program places IDA researchers at selected Combatant Command headquarters to improve the linkages between and among the commands, with particular emphasis on helping commands respond to evolving Pentagon planning and programming processes.

JAWD's staff members are highly educated, with about 90 percent having graduate degrees in academic disciplines ranging from physics, mathematics, and engineering to political science, economics, and history. Their professional experiences are similarly diverse, including individuals with combat service in the armed forces; civilian service in the Departments of Defense and State, the Intelligence Community, and law enforcement agencies; and positions in academia.

Research On-Site at IDA Facilities

In the past year, the division's research program – conducted by JAWD staff members located at IDA's offices in Virginia – has included the following areas:

- Developing joint operational concepts.
- Designing and executing joint experiments.
- Collecting and analyzing lessons from ongoing operations and relevant historical actions.
- Developing new training and education approaches that emphasize adaptability and build on the lessons of contemporary and historical experience.
- Exploring processes for faster delivery of new military capabilities to warfighters.
- Developing analyses and analytic capabilities of direct and immediate utility to forces in the field.
- Developing standards and implementing them by improved software designed to eliminate errors in digital mapping.

- Investigating the technology connecting live, virtual, and constructive simulations and helping DoD prepare a business plan for improving models and simulations related to irregular warfare.

Deployed Analysts in Iraq and Afghanistan

Since 2003, JAWD has led IDA's program of direct analytic support to commands in Iraq and Afghanistan. To date, more than 60 researchers from across IDA have deployed to these countries under JAWD tasks supporting the Joint Improvised Explosive Device (IED) Defeat Organization, Multi-National Corps-Iraq, Multi-National Force-Iraq, and International Security Assistance Force-Afghanistan. While overseas, these staff members have conducted analyses and advised operational commanders on tactical issues (e.g., countering IEDs, including studies of equipment improvements and financing of insurgent networks employing IEDs), as well as on broad strategy (e.g., evaluating the effects of the surge in U.S. forces and developing metrics for assessing overall progress in countering the insurgency). When they return to IDA, these researchers use knowledge and insights gained during field assignments with operational commands to inform other IDA studies dealing with U.S. strategy, operational concepts, force balance, acquisition, and training and education. They also provide reach-back support to analysts deployed overseas.

Improving the Understanding of Enemy Perspectives

Through publications and lectures to educational institutions, JAWD continues to provide a deeper understanding of enemy perspectives, derived from captured documents and tapes from the wars in Iraq and Afghanistan. Open source writings and correspondence addressing the perspectives of al Qaeda and associated movements by the movements' chief theorists are also included in these analyses. This body of work provides perspective on the drivers of enemy strategy, reasons for the behavior of Saddam's regime, and insurgent motives and actions in Iraq and Afghanistan.

Highlighted Study

Evaluating Biometric Information Technologies

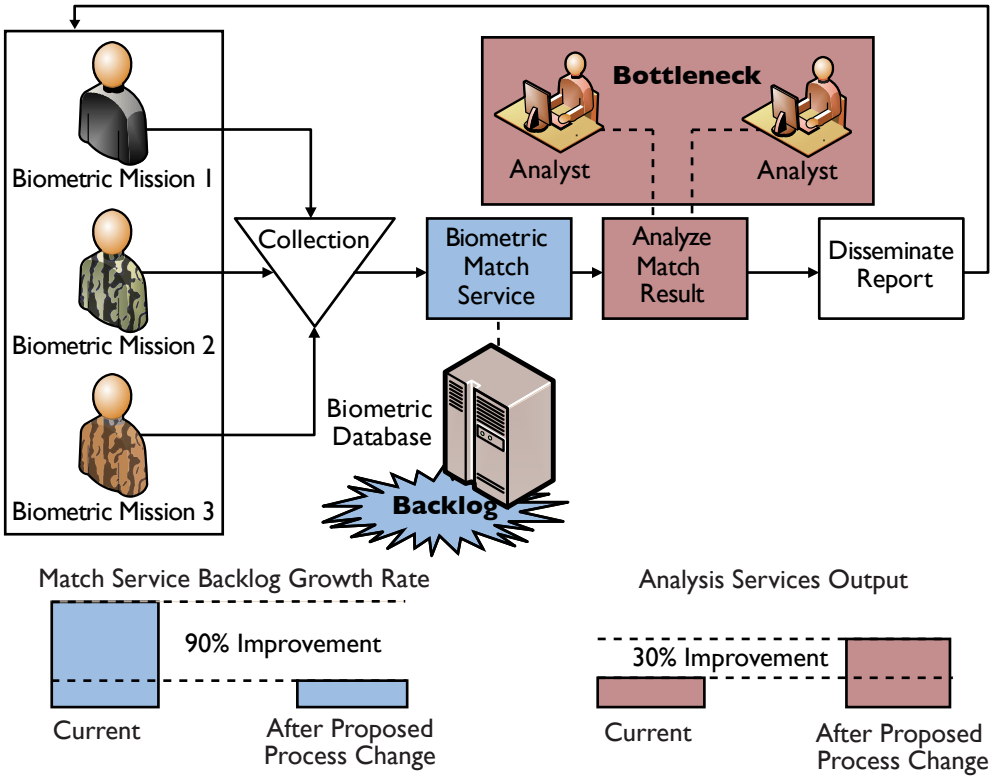
The Biometric Information Technology Evaluation project combines JAWD's experience with current operations and understanding of process modeling techniques to help improve DoD's use of biometric technologies in Iraq and Afghanistan. DoD's use of biometrics began with the deployment of a few independent systems to the field on an opportunistic basis without benefit of an overall program plan or unified direction. The result was that even after a few years of experience, DoD lacked a basic understanding of the performance of the systems and processes involved in biometrics applications and of how the individual components functioned together in support of critical identity management-related missions (e.g., base security, detainee operations, and population control).

DoD asked IDA to develop a baseline of the "as is" state of biometrics across the Department, and in particular, of biometrics systems being used in Iraq and Afghanistan. The objective was to inform decisions about future investments in biometric systems.

During the initial phase of the study, which included three trips into theater, our researchers determined that an appropriate "picture" could be developed using a process flow simulation that accounted for all biometrics components currently in use across all mission areas. This approach enabled us to assess both the performance of individual biometric components and the ability of the overall system to respond to day-to-day and stressing events. Bottlenecks that inhibited system responsiveness were identified, along with processing steps that were not directly addressed by the existing structure. Our model is now being used to examine various combinations of new systems and processes in order to determine their relative effects on the overall biometric support system.

An important study finding was that although many system users referred to a "biometrics mission," in reality biometric data collection and processing are not an end unto themselves. As a result of this insight and the success in improving biometrics system performance, DoD asked IDA to apply the same process flow analysis and simulation to analyze the multiple concepts of operations for forensics and intelligence, surveillance, and reconnaissance systems that have been fielded without integrating approaches.

JAWD Analyzed Change in the Defense Biometric Enterprise



A system-wide analysis reveals relative merits of potential changes in the defense biometrics enterprise. The analysis shows how large-scale changes in the Match Service might yield smaller results overall because of a potential bottleneck in the analysis of biometrics data.

Biometrics Analysis Team

Mr. George E. Lukes

Dr. Robert F. Richbourg

Mr. Timothy M. Stone

Operational Evaluation Division

The Operational Evaluation Division (OED) was formed in 1984 to provide analytical support to the Director, Operational Test and Evaluation (DOT&E), then a newly formed organization within the Office of the Secretary of Defense (OSD). DOT&E was established by Congress to address concerns about the independence of weapon systems testing. While support to DOT&E remains OED's primary focus, the division also provides independent analytical support to unified Combatant Commands and to the Department of Homeland Security (DHS). In addition, OED researchers have deployed to Iraq to provide direct analytical support to commanders in the field.

Supporting Test and Evaluation Across the Full-Range of DoD Systems

OED analysts have comprehensive knowledge of military systems and a deep understanding of the characteristics of successful test and evaluation programs. These capabilities – operating within IDA's conflict-free environment and with rigorous attention to quality – enable OED to provide trusted, objective analytic support across the full range of DOT&E's oversight responsibilities for operational and live fire testing. The work spans activities from evaluation planning and test design to data analysis and reporting of test results. Our researchers regularly observe field testing to gain valuable insights regarding how tests are conducted and to better understand and interpret results.

For example, in the past year, OED analysts were involved in the operational testing and evaluation of the Navy's newest type of nuclear-powered attack submarines, the Virginia class. In addition to working closely with the Navy on test design, OED analysts went onboard the USS *Virginia* to observe the at-sea tests conducted in 2008. In several cases, the design of the test event was based, in large part, on DOT&E recommendations that followed directly from the findings of OED researchers.

We also provided analytical support for DOT&E's "Beyond Low-Rate Initial Production" reports to Congress related to the Army's Stryker Mobile Gun System (MGS) and Mine Resistant Ambush Protected (MRAP) vehicle; the Marine Corps' upgraded H-1 helicopter; and the Navy's Mark 48 CBASS Torpedo, Ohio-class SSGN conversion, and Low Band Transmitter program.

The MGS report illustrates the contributions made by OED researchers. Based on our observations and data collected in operational and live fire testing, and our analyses of Iraq operations using the MGS, the DOT&E report concluded that the MGS would be effective and suitable for use in small-scale contingencies. The report also noted a number of shortcomings. The Secretary of Defense approved the MGS for deployment but directed the Army to develop a program to correct

the deficiencies. OED researchers have been working with DOT&E and the Army to develop a plan to assess and test the mitigation approaches.

Supporting Combatant Commands

In addition to supporting DOT&E's efforts, OED researchers also examine a wide range of contemporary national security issues facing Combatant Commands and The Office of the Under Secretary of Defense, Policy (OUSD (P)). This year, the team assisted the Joint Forces Command with the development and evaluation of the emerging whole-of-government planning and management concepts for future reconstruction and stabilization operations. The concepts, designed to integrate civilian and military resources within the Interagency Management System construct, were evaluated in the Unified Action series of experiments. In a parallel effort, the OED team evaluated a series of Interagency Mission Analysis workshops supporting the stand up of the new U.S. Africa Command. OED identified where the civilian and military organizations had common or related foreign assistance and security cooperation programs and recommended how they could work together to accomplish U.S. objectives more effectively across Africa. The team also supported European Command (EUCOM) and OUSD (P) plans in evaluating how DoD could more effectively engage interagency inputs to the contingency planning process, based upon lessons learned from the unique CONPLAN 4242 case study. Finally, the OED team continued its support of the Civil Military Emergency Preparedness exercises sponsored by OUSD (P) and the Headquarters Department of the Army in EUCOM's area of responsibility. After more than a decade of working with Balkan countries to develop and conduct workshops to facilitate cooperative regional disaster responses, this marks OED's fifth year of work focused on improving regional coordination among the Black Sea nations.

Helping DHS Implement the SAFETY Act

Working with the colleagues in CARD, OED researchers also provide analytical support to DHS in implementing the Support Anti-terrorism by Fostering Effective Technologies Act of 2002 (the "SAFETY Act"). The SAFETY Act provides a variety of litigation and risk management protections for sellers of "qualified anti-terrorism technologies." IDA has provided independent evaluations of hundreds of technologies over the past five years in support of DHS decisions on whether to grant SAFETY Act protections. A broad range of technologies has been examined, including explosive detection systems; chemical, biological, and radiological sensors; blast resistant materials; vulnerability assessments; software, including systems used by first responders; and security services. In addition to the initial evaluations of each technology, this year we began to assist DHS in developing the SAFETY Act Award Renewal Process.

MRAP Testing Team

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Mr. Scott R. Feil

Mr. Thomas R. King

Mr. Bruce A. Simpson

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Highlighted Study

Support for MRAP Testing

In response to the widespread use of improvised explosive devices by insurgents in Iraq, DoD initiated a rapid acquisition effort to procure and field Mine Resistant Ambush Protected (MRAP) vehicles. The MRAP program became one of the highest priority efforts in the Department. Though many items had previously been procured under the rapid-acquisition program, none had approached the scope of the MRAP effort, which ultimately grew to encompass six different vehicles from five vendors, numerous armor upgrades, and two ambulance versions. In comparison with other tactical wheeled vehicles such as the High Mobility Multi-purpose Wheeled Vehicle (HMMWV), MRAP vehicles provide increased passenger protection and improved vehicle survivability against battlefield threats in Iraq.

OED researchers supported the MRAP effort by helping DOT&E and the Joint Test Team design and evaluate the live fire and operational test programs undergone by all vehicle types. The tests had to replicate the environments and missions that MRAPs could encounter in Iraq. Drawing on extensive operational test experience, we developed a comprehensive test design that included an innovative use of open-air, counter-IED jamming – the first operational test to do so. The tests included operations in both desert and urban terrains. A team of OED researchers deployed to Yuma Test Center for six months of operational testing of vehicles from all five vendors.

OED Supported MRAP Testing in Yuma Proving Ground's "Little Baghdad"

An MRAP vehicle (foreground), and a less protected HMMWV (behind) conduct operations in Yuma Proving Ground's "Little Baghdad" as OED and other test personnel observe the Initial Operational Test. Testing replicates environments and missions MRAPs might face in Iraq.

OED analysts also participated in live fire vulnerability testing of the five production MRAP variants, the MRAP Expedient Armor Program, and the developmental MRAP II vehicles. Testing included the range of threats being encountered by operating forces today, including blast mines, blast-fragmentation IEDs, rocket-propelled grenades, explosively formed projectiles, and small arms. Because of the large number of vehicle types and required tests, testing and test planning continued throughout much of 2007 and 2008. OED researchers worked with the DOT&E sponsor and with analysts from the Marine Corps and Army in developing and executing a structured and rigorous test program that supported an aggressive schedule for MRAP design, development, and fielding. OED analysts used their considerable expertise in the test and evaluation of ground combat vehicles to advance the state of the art in crew casualty assessment and to link crew casualties to vehicle capabilities and responses. In 2008, IDA committed more than 48 staff-months to support this priority defense effort, which resulted in the rapid fielding of a needed capability to the operating forces. Five "Beyond Low-Rate Initial Production" reports were produced covering both live fire and operational testing.

Science and Technology Division

The Science and Technology Division (STD) was founded in the late 1950s to advise the Department of Defense on the advancement of basic and applied science and technology programs (S&T). Through the years, STD's core mission has remained unchanged: to provide high-quality, objective analyses of technology issues related to national security.

The government's need for competent technical evaluations and advice – provided by an organization free from conflicts of interest – has never been greater. Weapons and support systems have become increasingly complex, employing cutting-edge technologies within integrated multi-system architectures. Urgent operational needs have increased pressures to deploy new capabilities rapidly, while the size of the government's internal science and technology workforce has declined. It is in this environment that IDA sponsors continue to rely on STD to help meet a variety of technology challenges.

Evaluating Technology Maturity, Risks, and Options

Over the years, the government's premature commitment to some advanced technologies has led to acquisition program delays and cost increases. STD researchers have responded by bringing additional rigor to technology readiness assessments, and providing independent perspectives on technology risks and mitigation strategies. We also help analyze, develop, and execute comprehensive technology test plans to provide unbiased assessments of program performance. An example of these assessments is the testing efforts related to vehicle-mounted mine and IED detection featured in the study highlighted on the next page.

Developing and Evaluating Innovative Concepts

Working with experts across IDA, STD assists sponsors in developing and evaluating innovative concepts that promise improved mission effectiveness and/or reduced costs. These concepts generally exploit new discoveries in science or technology and require rigorous analysis to determine which concepts are technologically feasible and offer real improvements in operational capabilities. Often, these analyses will identify alternative concepts that could achieve mission objectives more efficiently.

An example of this process is the Directed Energy Roadmap for Expeditionary Warfare through which IDA is identifying user needs and evaluating different technology approaches. The resulting 15-year plan will describe technology risks, suggest alternative strategies for mitigating those risks, and highlight the S&T investments in experimentation and modeling needed to guide the development and fielding of new directed-energy sources.

Assessing Technological Opportunities

It is important to avoid overly optimistic assessments of emerging technologies, which divert resources in pursuit of innovative, but physically or operationally impractical, technical approaches. By remaining grounded in analyses and a deep understanding of realistic operational environments, STD researchers offer sponsors insight into technology trends and the impact of emerging advances on national security missions.

For example, a study of Active Protection Systems (APS) is examining the potential effectiveness of hard-kill APS for the protection of light, tactical wheeled vehicles. This is a technically challenging mission, given the short engagement times and potentially complex operational environment. Our evaluation will include foreign and domestic systems that could be available in the near term. We will incorporate data from live-fire tests, and consider plausible operational concepts in realistic irregular warfare environments.

Improving DoD's S&T Linkages to Academia

The Department of Defense is no longer the primary driver of advances in many technology areas. Instead, commercial/non-military markets and applications have become the focus of most advanced research in industry and academia. As a result, fewer researchers in U.S. colleges and universities are working on – or are even aware of – national security technology challenges.

DoD has asked IDA to help strengthen connections between the federal government and relevant S&T communities in academia. For many years, we have run the Defense Science Study Group where leading, recently-tenured faculty have been introduced to security challenges and related technology problems. More recently, IDA began running a similar program focused on computer scientists. We are also assisting Director, Defense Research and Engineering, in implementing the new National Security Science and Engineering Faculty Fellowship Program, which supports unclassified basic scientific research by distinguished university faculty and staff in critical areas of interest to DoD.

Highlighted Study

Vehicle-Mounted Mine and IED Detection

To support combat and logistics missions in Iraq and Afghanistan, DoD is developing vehicle-mounted systems capable of detecting and neutralizing mines and improvised explosive devices. Recently, STD researchers evaluated several alternative systems that use ground-penetrating radar (GPR) to detect buried objects. One of these systems is now undergoing an in-theater assessment in support of Operation Enduring Freedom.

STD researchers developed software that compares the raw data collected from the sensors and computes performance metrics as a function of several key parameters.

By using the raw data and building a graphical user interface where algorithms could be applied to the data one step at a time, we were able to compare different sensors at the same processing point in each system tested. This allowed us to evaluate sensor performance independent of other system characteristics and test conditions – such as vehicle integration, training, and soil composition and wetness – that sometimes make it difficult to identify the best sensor.

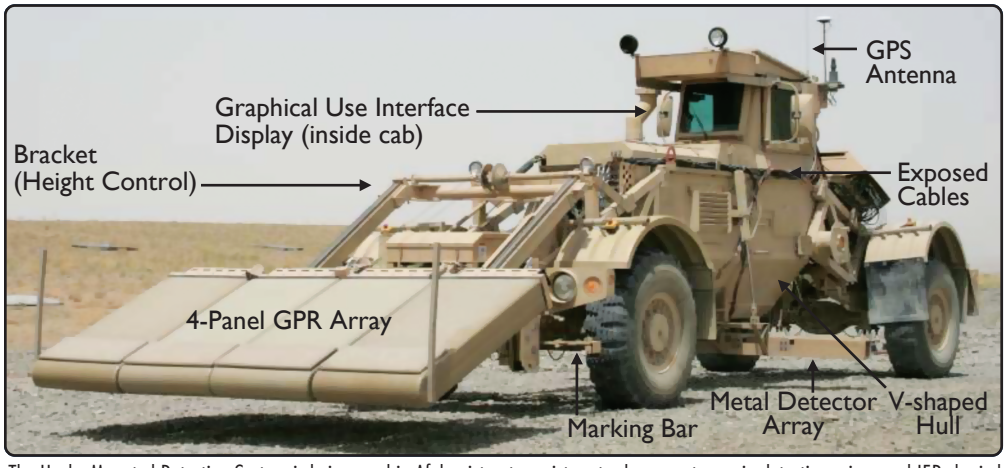
Developing the Mine and IED Assessment and Scoring Tool

In 2008 we designed, monitored, analyzed, and reported on a test of nine different sensors of varying technological maturity. To assess the results of these tests in a timely manner, our researchers developed the Mine and IED Detection Assessment and Scoring (MIDAS) tool. MIDAS is now used extensively by algorithm working groups in support of a variety of countermine programs. This suite of software codes computes detection probabilities, false alarm rates, position accuracies, and system biases while also creating receiver-operator characteristic curves.

Using MIDAS to Assess Performance of the Husky Mounted Detection System

The Husky Mounted Detection System (HMDS) consists of a down-looking GPR designed to automatically detect buried mines and IEDs in roadways. Recently, the HMDS was sent for an in-theater evaluation in Afghanistan. Prior to deployment, tests were conducted to see if the system was compatible with a set of jamming technologies that would operate in close proximity to the GPR. We used MIDAS to compare the detection performance as a function of separation distance. STD researchers continue to support the on-going assessment of HMDS in Afghanistan, analyzing data collected to guide improvements to the system.

STD Assessed HMDS Performance Using MIDAS



The Husky Mounted Detection System is being used in Afghanistan to assist route clearance teams in detecting mines and IEDs buried in roadways. The GPR is mounted in front of the vehicle. IDA has provided in-depth analyses and assessments of this radar over several years.

MIDAS Team

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Mr. Erik M. Rosen

Strategy, Forces and Resources Division

The Strategy, Forces and Resources Division (SFRD) conducts integrated, interdisciplinary studies of broad defense policy and long-range planning related to national strategy, organizational, and management process issues. SFRD researchers analyze the capabilities of military forces, homeland defenses, and defense support and infrastructure programs. It develops analytical methodologies, quantitative studies, and simulation techniques. These activities meet a broad range of sponsor needs while providing context for research focused on systems and technologies. In order to support DoD's planning processes, we have also developed improved analytical tools for assessing and managing overall force and program risk. These tools are intended to inform decision-making during Quadrennial Defense Reviews as well as in the annual planning, programming, and budgeting process. Some examples of recent work are highlighted below.

Analyzing Chemical and Biological Defenses

For many years, SFRD researchers have examined the capabilities of U.S. forces to defend against chemical and biological attacks. The work has involved all aspects of chemical-biological defenses, from detailed studies of threat agents to medical treatment of casualties, and from defending military forces on the battlefield to protecting civilian populations against terrorist attacks. A recent study in this area is highlighted on the next page.

Designing Defense Planning Scenarios

As part of its ongoing support of long-range planning for national security strategy and infrastructure, SFRD analysts continued designing a "living library" of defense planning scenarios (DPSs) for use by DoD in preparing Department-wide guidance for the development of future forces and capabilities. DPSs provide tangible examples of important force planning challenges, centered on specific countries and highlighting key challenges, strategic objectives, and strategic concepts to meet objectives. DoD components use DPS products in analyzing and programming for future forces and capabilities.

Conducting Organizational Studies

SFRD researchers examine major organizational and management process issues. The largest of these studies in 2008 addressed government-wide responsibilities for national security space systems and operations. The study recommended significant changes in overall organization, in the roles of key agencies, and in resource management practices for U.S. space activities.

Improving Defense Resource Management

For 15 years, IDA's Defense Resource Management Study (DRMS) teams have worked with foreign ministers of defense and key senior military staffs to help them fashion balanced, affordable defense programs. The goal is to help key American security partners increase their military capabilities through improved management of defense resources. The program initially focused on helping prepare the new Eastern European democracies for NATO membership. Since 9/11, its focus has been on key American security partners that are dealing with extremist groups and terrorism. In 2008, IDA DRMS teams continued their work in Indonesia, the Philippines, and Thailand, and began new projects in Cambodia and southern Sudan.

Providing Manpower Studies

SFRD's work on manpower economics continued to focus primarily on Reserve Component (RC) mobilization, compensation, and employer-support issues. The division also provided continuing analyses on relieving deployment stress on U.S. Army Active and RC forces.

Detection of Radiological and Nuclear Threats

In keeping with its focus on developing analytical methodologies, SFRD developed metrics for the evaluation of potential technologies for standoff detection of concealed nuclear material. This methodology uses the underlying physics to connect the technical parameters (e.g., voltage and current) to the sensor characteristics of interest to the operational forces (e.g., dwell time and search volume).

Law Enforcement Support to Global Anti-terrorism Operations

For many years, IDA has been analyzing ways to defeat insurgencies supported by violent criminal networks. In 2008, SFRD – under the sponsorship of the Department of State and the United Nations (UN) Office of Drugs and Crime – convened an international conference at the UN Vienna International Centre to examine similarities among worldwide insurgencies in Iraq, Colombia, Afghanistan, and many other countries.

Highlighted Study

Operational Challenge Study

For several decades, the requirements for passive chemical defense equipment have been standardized to levels associated with the chemical threat posed by the former Soviet Union. These criteria have been applied to protective

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Dr. Don A. Lloyd

Mr. Douglas P. Schultz

overgarments, collectively protected shelter materials, masks, and filters. However, the reasons for specific values used for some criteria are poorly documented and out-of-date in light of post-cold war threats. To provide an updated, documented, and defensible basis for future investments in chemical defensive equipment, DoD asked IDA to conduct an Operational Challenge Study to characterize chemical challenges (deposition or vapor levels) in a modern, operational context.

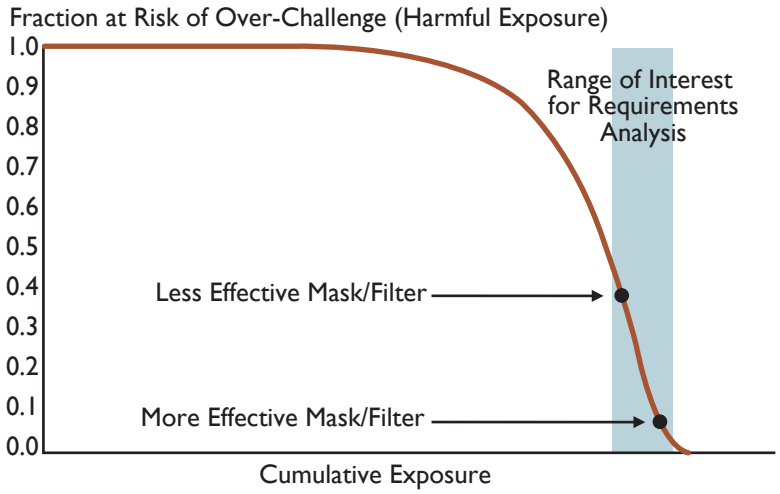
To ensure the results of the study would be consistent with DoD planning assumptions, we based the analysis on a conventional campaign using an approved Defense Planning Scenario. This campaign scenario, prepared by the Joint Staff's and OSD; was augmented by the Center for Army Analysis, which characterized potential chemical artillery operations.

We developed plausible sub-brigade target sizes and unit configurations, and applied a model for the adversary's chemical tactics drawn from documented sources. Chemical theater ballistic missile attacks were adapted from a separate "leaker" analysis done by the Defense Threat Reduction Agency.

By examining all the chemical engagements in the campaign, we were able to quantify the percentage of unit and/or installation areas covered at different challenge levels, and construct functions of relative risk to U.S. assets due to chemical exposures. These functions can be partitioned by almost any aspect of the campaign, including U.S. asset type, adversary weapon system, season of the year, phase of the campaign, and so on.

As a result of the study, future needs for defensive equipment will be based on a documented and analytically transparent methodology. Also, it will be possible to quantify increased or decreased risks associated with different levels of investment in defensive equipment.

SFRD Assessed Risk Tradeoffs Associated with Changes in Gas-Mask/Filter Requirements



SFRD's work provided a precise understanding of how the risk of harmful troop exposure changes in relation to adjustments to the protection-level requirements for gas masks and filters. The study aggregates risk over many aspects of a campaign for use in follow-on chemical protection and decontamination requirements analyses.

System Evaluation Division

The System Evaluation Division (SED) conducts assessments of military utility, system performance, and joint and allied interoperability. SED also performs broad assessments of mission needs, develops system architectures, investigates new operational concepts, and examines the risks and costs that accompany technology integration. These efforts typically involve assessments that must integrate analyses of technical performance, mission effectiveness, system cost, and often, discussions of policy implications. Our assessments assist DoD in making choices among competing systems, in setting force or inventory levels, and in identifying suitable concepts for employing systems in wartime. Selected Division competencies are discussed below.

Performing Cost and Operational Effectiveness Analyses

SED analysts have conducted cost-effectiveness studies across the full range of DoD systems and mission areas. In 2008, we completed a study requested by Congress of fixed-wing transportation aircraft. The study examined DoD strategic and tactical airlift needs for military and commercial aircraft in circumstances ranging from peacetime to major combat. All tradeoff analyses balanced life-cycle costs and operational effectiveness in potential military scenarios in the years between 2012 and 2024. About 40 different future airlift fleets were examined and compared in the study.

Formulating and Evaluating New Operational Concepts

We also investigated new operating concepts that include unmanned aircraft serving as airborne relays to improve tactical communications, especially connectivity at the lowest tactical levels of ground forces while on the move. We modeled four radio frequency propagation environments – mountain, desert, jungle, and urban – and four plausible tactical movements over six hours, in each case assessing the performance of differing airborne relay alternatives. The investigated alternatives included high-flying fixed-wing aircraft, lower-flying fixed-wing aircraft, rotorcraft, and concepts such as dedicated aircraft or relays of opportunity. These ground forces tactical network analyses are being used to quantify the value of airborne relay and identify promising concepts of operation.

Conducting Force Effectiveness Studies

We are often asked to assess fleet or system options within the context of a broad force structure. Recent examples include a bomber force structure study and an Unmanned Combat Air System utility study. We maintain a set of modeling and simulation tools and databases that enable us to conduct these complex air warfare assessments in a timely fashion. Our recent analysis of ballistic missile defense (BMD) options for Europe also required the consideration of broad force structure elements, as described in the highlighted study on the next page.

BMD Assessment Team

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Ms. Susan L. Clark-Sestak

Dr. John S. Hong

Dr. David E. Hunter

Dr. Andrew C. Kim

Technology Integration and Evaluation

Some SED studies focus on integrating new technologies and capabilities into broader mission architectures. For example, SED led a technical evaluation of options for the Space Tracking and Surveillance System, a proposed set of midcourse ballistic missile tracking satellites. By designing original satellite constellation alternatives and examining consequent launch considerations, we found potential payload mass improvements. SED analysts also independently analyzed potential sensor performance parameters and the coverage performance of the various satellite constellation designs.

Operational Analyses and Lessons Learned

SED assesses the performance of forces and systems in ongoing military operations. As part of a large study of Operation Iraqi Freedom, we were asked to quantify the impact of the 2007 surge of forces and the concomitant change in counterinsurgency strategy on indicators of security in Baghdad. To do so, we conducted carefully controlled time series and geospatial analyses that accounted for underlying trends that were already underway before the start of the surge. This allowed us to establish and quantify a number of associations between blue force operations and indicators of violence that suggested the ultimate importance of the changes in tactics that were enabled by the additional troops.

Highlighted Study

Independent Assessment of the Proposed Deployment of Ballistic Missile Defense Systems in Europe

The United States has proposed deploying BMD systems to Europe to protect the United States and Europe from a limited ballistic missile attack from Iran. The major components are the X-band, European Midcourse Radar (EMR) in the Czech Republic; the European Interceptor Site – with 10 silo-based ground-based interceptors – in Poland; and a forward-deployed, X-band AN/TPY-2 radar in the Caspian Sea region. The proposed deployment is intended to be operational by 2012–2013 and provide full-time coverage.

IDA conducted the congressionally mandated independent assessment of the proposed U.S. deployment and alternative architectures. The study included assessments of:

- The Iranian threat, including ballistic missiles of all ranges;
- Technical capabilities of the BMD systems, including capabilities

against countermeasures and raids;

- Mission effectiveness, including radar tracking, geographical coverage, and number of shot opportunities;
- Costs, including development and fielding, operating and support, and 10-year and 35-year life-cycle costs;
- Political implications, including the ongoing bilateral negotiations with the Czech Republic and Poland, challenges associated with deploying a forward radar in the Caspian Sea region, and U.S. relationships with the North Atlantic Treaty Organization and Russia; and
- Operational issues, including force structure and BMD command and control arrangements.

The main alternative architectures examined were based on Aegis BMD cruisers and destroyers with the Standard Missile 3 (SM-3) Block IB (for 2015) or the longer-range, more-advanced SM-3 Block IIA (for 2020). For each SM-3 variant, the study examined architectures with and without support from land-based X-band radars (specifically, the EMR and TPY-2). In addition, we optimized the number of ship stations and their locations to achieve the best coverage.

The study team also estimated the total number of ships required to maintain and sustain the ship stations given a continuous readiness posture, consistent with the planned land-based deployment. In one case, the ships were based in the continental United States and had one crew per ship. This reflects current practice and requires four ships to maintain a single station continuously in Europe. We also considered a notional second case, that assumed two crews per ship as well as forward basing for crew turnover and maintenance.

To account for the use of the Aegis ships on a full-time basis, we estimated average yearly ship depreciation costs, reflecting an opportunity cost if existing ships are used. We also noted that to reduce costs, the Aegis ships could potentially not be dedicated full time to the European BMD mission, assuming a readiness posture based on a suitable warning period.

IDA Team Assessed Aegis Ships for European BMD Deployment

The IDA European BMD assessment team examined alternative architectures based on Aegis BMD cruisers and destroyers like the USS *Shiloh*, pictured above, with SM-3 launchers.

BMD Assessment Team

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RADM. Grant A. Sharp

Mr. Robert V. Uy

Dr. Laura M. Williams

Dr. Gary F. Willmes


Computing
Research
Security
Center
cryptography
development
high-performance
CCS
CCR
NSA
NSA's
mission
missions
data
technological
Centers
information
problem
intelligence
providing
protecting
large
program
computer
signal
signals
network
Web
reflect
Sciences
platforms
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techniques
solving
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senior
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protection
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global
scientists
demanding
laboratories
computational/mathematical
collaborations
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computer-network
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blending
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qualified
active
engineers
exceed
endeavors
various
important
role

Center for Communications and Computing

For more than 50 years, IDA has provided cutting-edge research in mathematics and computer science to the National Security Agency (NSA) as part of its mission to protect our national security information systems against exploitation and to provide the United States with effective foreign signals intelligence. While the sensitivity of this work requires that most of it to be highly classified, we can, in very general terms, offer an outline of IDA research in the areas of communications research and computing research.

Center for Communications Research

Center for Communications Research Focus Review Panel

George Andrews
Pennsylvania State University

Noam Elkies
Harvard University

Charles Fefferman
Princeton University

Ronald Graham
University of California at San Diego

Jill Mesirov
Broad Institute of MIT and Harvard

William Press
University of Texas at Austin

Kenneth Ribet
University of California at Berkeley

Christopher Skinner
Princeton University

Peter Weinberger
Google, Inc.

The Center for Communications Research (CCR) sites in Princeton, New Jersey, and La Jolla, California, performs mathematical and algorithmic research that supports the NSA's missions. This includes work in cryptology, signal processing, speech, information processing, and network security.

The constantly evolving intellectual terrain in these areas provides a regular stream of new problems. These challenges require two sets of skills from CCR researchers: general problem-solving ability, nurtured by advanced training in a mathematical science, and the ability to apply highly specialized techniques that have found surprising applications in communications security. While the day-to-day work of CCR researchers ranges from doing abstract mathematics to writing sophisticated computer software, there is always an emphasis on providing practical solutions to important real-world problems.

Many branches of the mathematical sciences have proven to be useful for these purposes. For example, techniques from the geometry of algebraic curves provide novel and unexpectedly effective methods for detecting and correcting errors in data transmission. Moreover, statistical and algorithmic ideas have become critical in understanding and carefully analyzing information flow.

The success of the CCR sites has been fostered by their vibrant and exciting work environment. The deeply challenging problems, and their evident importance and applicability, are attractive to staff and visitors alike. In addition, there is a tradition of broad and intense collaboration among researchers. The resulting diversity of approaches often leads to serendipitous insights coming from areas of mathematics that seem far removed from the original problem. For these reasons, the CCR sites employ researchers with backgrounds across a wide variety of mathematical sciences, and this breadth is continually expanded through further training and new hiring.

Recruiting the very best mathematical talent is critical to our work. To do this we maintain connections with the academic community, have our research staff attend conferences and publish unclassified work in the larger academic world, and invite cleared academics to attend workshops held at each CCR site. In addition, the CCR sites have an advisory panel of distinguished mathematicians and scientists to help us recruit staff, stay in touch with outside work, and evaluate our research efforts.

The most important recruiting opportunity for academics at the CCR is our annual SCAMP summer program. For eight to ten weeks each year, visiting mathematicians, statisticians, and computer scientists work side by side with

full-time CCR staff and visitors from NSA, focusing on a few specific difficult problems. Most SCAMP visitors are full-time faculty or graduate students. The CCR grew out of these summer programs in the 1950s and, throughout its history, this influx of new people and ideas has led to the solution of important problems in communication security.

Center for Computing Sciences

The Center for Computing Sciences (CCS) in Bowie, Maryland focuses the skills of some of the country's best computer scientists, engineers, and mathematicians not only on solving intelligence-related problems of importance to national security, but also on tackling problem sets of interest to the entire computing-science world. CCS's mission, originally dedicated to the development and use of high-end computing, has expanded over the years to reflect global-political and technological changes, including high-performance computing for cryptography, cryptography itself, network security, signal processing, and computational/mathematical techniques for mining and "understanding" very large data sets.

One of the problem sets CCS is working on is the development of high-performance computing platforms – an effort that senior technology policymakers note will require government research and development support. These platforms, aimed at meeting the specialized requirements of the most demanding national-security-related computations, will have to far exceed the capabilities of even the most sophisticated computers today. With a depth of experience in NSA's most advanced computing problems; a history of sustained and vigorous dialog with many of the nation's leading high-end-computer makers; and active collaborations with the Defense Advanced Research Projects Agency and the Department of Energy's Lawrence Livermore, Sandia, and Oak Ridge national laboratories the Center is uniquely qualified to provide significant insight into this challenge.

CCS also conducts research in the area of computer-network and communications security. For example, the center's SCAMP summer program examines the complex, sometimes unintended, and possibly unpleasant ways that various software components interact on individual workstations and over very large networks (e.g., the World Wide Web). "Home" to U.S. adversaries who use the same technologies as U.S. entities, the World Wide Web has affected the blending of two, formerly distinct, NSA missions: data protection and data collection. CCS is working closely with the CCR and NSA to bring the best talents to bear on the scientific problems created by this new, blended mission.

Like the CCR, the CCS has an outside advisory panel consisting of respected computer scientists, engineers, and mathematicians.

Center for Computing Sciences External Review Panel

John H. Birely
University of California

Ronald Boisvert
National Institutes of Standards and Technology

John E. Burroughs
Former DoD Employee

George Cybenko
Dartmouth College

Mary Jane Irwin
Pennsylvania State University

Daniel I. Meiron
California Institute of Technology

Jill Mesirov
Broad Center of MIT and Harvard

Barton P. Miller
University of Wisconsin

William H. Press
University of Texas

Paul R. Prucnal
Princeton University

Peter Weinberger
Google, Inc.


Science
Technology
Policy
government
developments
support
Civil
nonprofit
widely
abroad
trends
sectors
Energy
analysis
Centers
education
response
Digest
authoritative
Office
data
providing
regarding
assisted
roles
Engineering
portfolio
higher
Executive
Department
objective
portfolios
long-term
Institutes
States
U.S
high-quality
analyses
Congress
clinical
Committees
Advisors
understanding
Infrastructure
concepts
technologies
information
development
attention
STPI
National
Security
institutions
legal
united
act
analytic
new
identifying
STPI's
application
Council
Institute
representatives
perspectives
issues
Health
agreements
research
environment
OSTP
Indicators
NIH
appropriate
available
critical
key
Panels
consultations
projects
interagency
alternatives
significant
analyze
federal
ensuring
growing

Science and Technology Policy Institute

Chartered by Congress in 1991, the Science and Technology Policy Institute (STPI) provides timely and authoritative analyses of significant science and technology developments in the United States and abroad for the White House Office of Science and Technology Policy (OSTP) as well as a growing number of additional federal organizations, including the National Institutes of Health (NIH) and the Department of Energy (DOE).

Since IDA began operating it in 2003, STPI has provided rigorous and high-quality support for OSTP on topics spanning from the ethical, legal, and societal implications of nanotechnology research to aeronautics research and development; and from understanding the effects of U.S. visa policies to efforts that facilitate international research collaboration. In carrying out its work, STPI researchers consult widely with representatives from private industry, academia, and nonprofit organizations.

STPI's key functions are to

- Assemble and analyze timely and authoritative information regarding significant science and technology (S&T) developments and trends in the United States and abroad, with a focus on how these developments affect the federal research and development portfolio and interagency and national issues;
- Analyze alternatives for ensuring the long-term strength of the United States in the development and application of S&T, including identifying the appropriate roles for the federal government and other sectors; and
- Provide technical support for the President's Council of Advisors on Science and Technology and for committees and panels of the National Science and Technology Council.

This past year, STPI's involvement in energy and the environment has increased in response to the growing importance of S&T-related issues on these topics. For example, in support of DOE, STPI analysts developed an interactive desktop model that projects directional changes (as opposed to precise numbers) in carbon emissions and the adoption of advanced technologies across energy supplies (nuclear, coal, and natural gas) in response to various policy scenarios.

Large science agencies like the National Institutes of Health often struggle to evaluate, manage, and even describe the portfolios of research they fund. STPI researchers supported the NIH Office of the Director in assessing the uses of portfolio analysis by NIH, and by working as part of the team that developed the conceptual design of a new public data system that will enhance the functionality available through the existing Computer Retrieval of Information on Scientific Projects tool.

In 2008, STPI continued its support of the National Cancer Institute (NCI) with seven projects. The most notable was development of a set of proposed standardized clauses for cancer clinical trial agreements between academic cancer centers and industry sponsors. Negotiating these agreements is often one of the important contributors to the delays encountered in the startup of clinical trials. By analyzing 50 negotiated clinical trial final agreements provided by 11 pharmaceutical companies and 14 NCI-supported Cancer Centers, STPI researchers determined that there was approximately 70 percent convergence on the majority of concepts that typically delay or complicate negotiations. Standard clauses representing those concepts were developed and then reviewed by business and legal representatives from the organizations providing the agreements and are now being implemented to facilitate the startup of clinical trials.

STPI analysts also assisted the National Science Board in creating the first *Digest of Key Science and Engineering Indicators (SEI) 2008*, which presents a limited selection of leading measures from the Board's *Science and Engineering Indicators (SEI) 2008* and other data. The Digest serves two purposes – to draw attention to important national and international trends in science and engineering, and to introduce readers to the data resources available in the main volumes of *SEI 2008* and its associated products. STPI staff also designed a Web-based, interactive version of the Digest. The STPI team is expanding its work to include the development of another online, interactive tool for use with *SEI 2010* specifically to reach out to the education community.

This past year, we assisted the leadership at the Technology Innovation Program (TIP) at the National Institutes of Standards and Technology in identifying areas of critical national need by performing an analysis of the research and development portfolios of the government and industry. This led to the identification of technology challenges that are not actively being addressed within the broad fields of Energy, Manufacturing, Civil Infrastructure, and Green Chemistry. In the fall of 2008, based on our findings and recommendations, TIP introduced funding in the area of Sensors and Sensing Systems for Civil and Water Infrastructure.

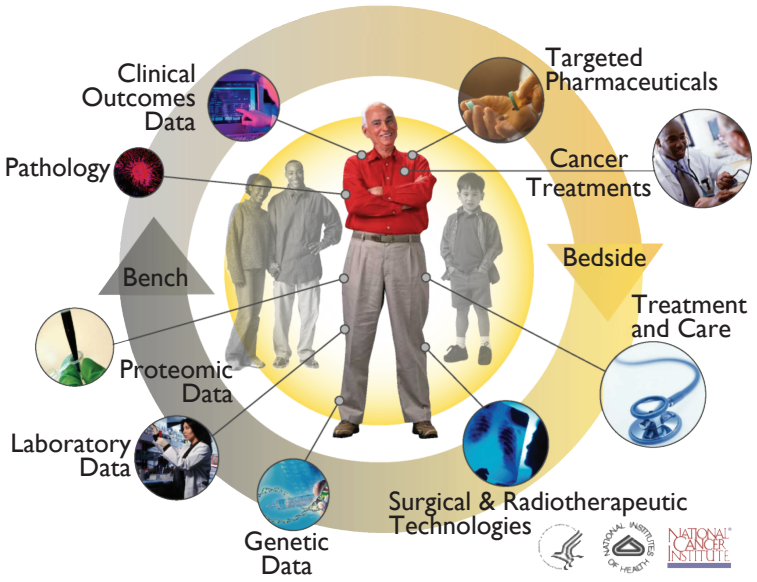
To explore how innovation occurs and how it affects growth, the Bureau of Economic Analysis (BEA) asked STPI to provide a review of innovation from the business perspective. STPI researchers reviewed the innovation literature, examined Community Innovation Surveys conducted by other countries, and met with several firms to find out how they measure innovation. The summaries of these discussions provide compelling evidence that firms do not track this kind of information in any systematic way and that even those that do have very different methods and perspectives. However, they indicated that if asked by BEA, they could align their systems to provide innovation information.

Highlighted Study

Priorities for Personalized Medicine – Report of the President's Council of Advisors on Science and Technology

"Personalized medicine," adjusting treatment to specific patient characteristics, has long been the goal of physicians. Recent advances in genomics and molecular biology are revealing an array of molecular markers that promise to vastly increase the ability to stratify patients in clinically useful ways. Such markers can lead to a new generation of genomics-based molecular diagnostics for identifying and/or confirming disease, assessing risk of disease, and distinguishing patients who will benefit from specific interventions from those who will not or who may suffer side effects.

"Personalized" Targeted Cancer Care



Tailoring care to the individual throughout the healthcare process is expected to decrease costs through early identification of patients who will benefit from specific treatments (or suffer certain side effects). The effective stratification of patients (based on increased patient data) could also reduce the cost of clinical trials.

The current high level of public policy interest in personalized medicine is attributable not only to the promise of improved patient care and disease prevention, but also because personalized medicine could mitigate two adverse trends; the increasing cost of health care and the decreasing rate of new medical product development. Distinguishing in advance those patients who will benefit from treatment and those likely to suffer adverse side effects could result in cost savings; stratifying patients by likely re-

Personalized Medicine Team

Dr. Judith A. Hautala

Mr. Oren Grad

sponse to treatment could reduce the cost of clinical trials, thus facilitating new product development.

This convergence of scientific opportunity with public health need led the President's Council of Advisors on Science and Technology (PCAST) to undertake a study to develop policy recommendations to advance the progress of personalized medicine, and OSTP requested strategic and analytical support from STPI.

STPI researchers worked with the PCAST Personalized Medicine Subcommittee Chair and OSTP staff to analyze the relevance to personalized medicine of eight major policy areas: technology/tools, regulation, reimbursement, information technology, intellectual property, privacy, physician and patient education, and economics. We prepared background papers for and analyzed the results of several external meetings convened to obtain input from a broad range of stakeholders representing academic institutions, medical diagnostics and imaging companies, biotechnology and pharmaceutical companies, insurance companies, patient providers and advocates, venture capital firms, trade and professional associations, and government agencies.

Based on this analysis and input, we recommended that policy actions in the realm of genomics-based molecular diagnostics would have the greatest potential to accelerate progress in personalized medicine. STPI analysts further identified three areas – technology/tools, regulation, and reimbursement – where defined policy actions would be critically important to near-term progress in the development and introduction into practice of these medical innovations. In response to our analysis, the Subcommittee Chair and OSTP asked us to prepare a PCAST personalized medicine report focused on these recommended actions.

The report, entitled "Priorities for Personalized Medicine," was published and sent to the President in September, 2008. With regard to technology and tools, PCAST recommended that the federal government develop a strategic, long-term plan to coordinate public and private research and development in molecular diagnostics, including achieving the proper balance of discovery versus development; prioritizing diseases that would most benefit; and investing in the biospecimen repositories, population cohorts, and standardized methodologies necessary to validate genomic correlations with disease.

In the area of regulation, PCAST recommended that the Food and Drug Administration implement a more transparent, systematic and iterative approach to the regulation of molecular diagnostics and clarify issues that complicate product development. In reimbursement, PCAST recommended that insurers determine coverage and payment for molecular diagnostics based on clinical benefit not just as analytic tests. Finally, because all the recommendations affect agencies of the Department of Health and Human Services (HHS), PCAST further recommended that HHS establish an office to coordinate all federal activities relevant to personalized medicine.

IDA Community

IDA's mission is to empower the best scientific and strategic minds to research and analyze the most important issues of national security of the day. Our diverse mix of professionals provides IDA with the multidisciplinary talent and expertise it needs to respond to the challenges presented by our sponsors. The exceptional creativity and determination that these individuals bring to their work with IDA's sponsors and each other is the foundation of IDA's reputation for excellence.

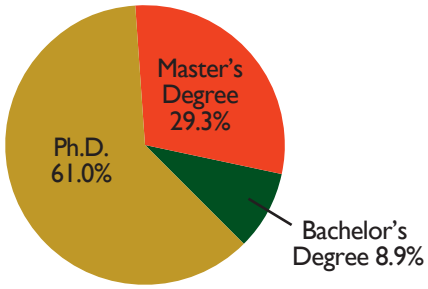
Service – Quality – Independence – Respect

IDA's core values – providing service to our nation, conducting quality research, maintaining our independence and integrity, and respecting one another – are at the heart of our organization. The strength behind these words and our ability to provide the caliber of research for which we are known, are a testament to the men and women who work at all of our FFRDCs.

IDA Staff at a Glance

IDA employs some 1,500 research, professional, and support staff in offices in California, Virginia, Maryland, Washington, DC, and New Jersey. Over 90 percent of IDA's research staff has an advanced degree, three out of five, a doctorate.

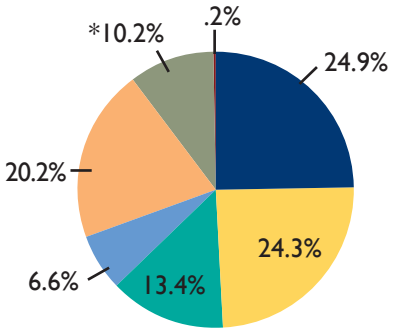
Education Level (All IDA)



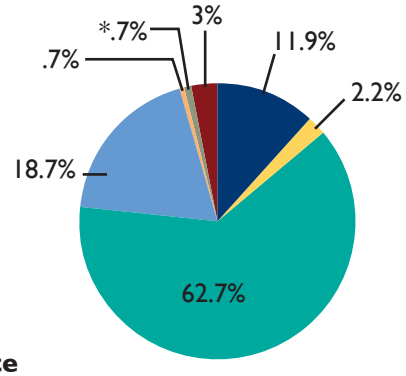
In addition to working on some of the most challenging projects in national security, researchers at IDA collaborate with a diverse and talented set of colleagues, many of whom are at the top of their fields. The breakdown of disciplines among our three FFRDCs reflects each center's analytic focus. The Studies and Analyses Center, which works in the

Discipline Breakdown by FFRDC

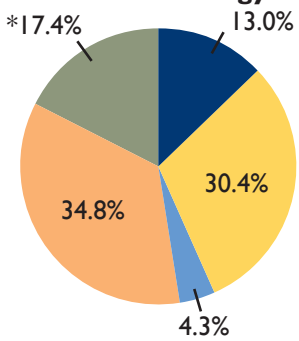
Studies and Analyses Center

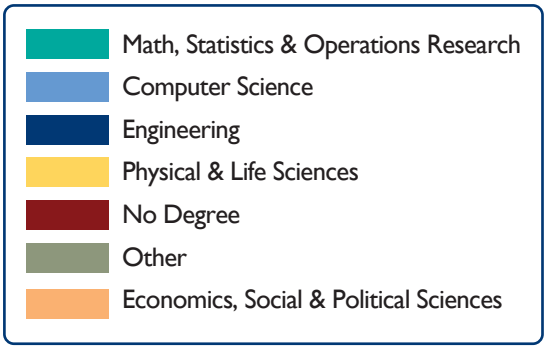


Center for Communications and Computing



Science and Technology Policy Institute





* Includes Business Administration/Management, Humanities.

areas of operational and systems evaluations and science and technology analyses, has a particularly strong cadre of analysts with degrees in the physical sciences and engineering. The Center for Communications and Computing, with its strong capabilities in cryptology, and the many disciplines of computational science and engineering, is heavily weighted toward mathematics, statistics, and operations research. Finally, STPI, with its broader science and technology charter, has a staff whose backgrounds are more evenly distributed across the disciplinary spectrum.

Recognizing Excellence

Each year, IDA recognizes staff members who exemplify our core values and dedication to excellence. Research staff members receive the Andrew J. Goodpaster Award for Excellence in Research while two additional awards, the William Y. Smith Award for Excellence and the President's Award for Excellence, recognize the accomplishments of nonresearch staff members.

The 2008 Goodpaster Award was presented to Dr. Michael Fischerkeller of the Joint Advanced Warfighting Division. Dr. Fischerkeller provided on-site support to U.S. Pacific Command, where he developed an improved risk assessment methodology to identify capability needs and relate those needs to operations plans, also known as Linking Plans to Resources or LPTR. In 2006 the Chairman of the Joint Staff directed the use of LPTR or its principles for all resource submissions by the U.S. Combatant Commands (COCOMs). In four years, Dr. Fischerkeller's idea was transformed from a concept to an experiment to a DoD-wide practice that changed the way COCOM needs are identified, compared, prioritized, and addressed in DoD's resources allocation process.

In 2008 Dr. Fischerkeller volunteered to participate in a JAWD effort to place two analysts at the headquarters of Multi-National Force-Iraq (MNF-I) in Baghdad. While on this assignment, Dr. Fischerkeller developed an approach for prioritizing and assessing the comparative importance of U.S. national and command objectives in Iraq. This work, which also sought to help define and measure progress toward success, was briefed to then MNF-I Commanding General David Petraeus, who endorsed Dr. Fischerkeller's approach. Dr. Fischerkeller is currently participating on a commission to draft a strategy for the entire U.S. Central Command area of responsibility.

The 2008 Smith Award for Excellence was presented to John Gray in the System Evaluation Division, and the President's Award for Excellence for 2008 went to Scott Gannon of the Communications Services Group.

Award Winners

Dr. Michael Fischerkeller

Dr. John M. Gray

Mr. Scott W. Gannon

Creating an Environment That Fosters Excellence

IDA is also committed to creating and maintaining an intellectually and professionally stimulating work environment that nurtures and encourages continued professional growth. These efforts include providing researchers and support staff alike with opportunities to keep abreast of the latest developments in their areas of expertise, whether by attending or presenting at conferences and symposia, pursuing additional formal educational opportunities, or publishing in key professional journals and other publications.

IDA invites key decision-makers and leaders to speak as part of the IDA Seminar Series. These midday talks, held at both the Studies and Analyses Center and the Center for Communications and Computing, are on a variety of topics, including specific defense issues, as well as other aspects of national security, and touch on related subjects such as international relations, economic policy, and technology. A sample of this past year's speakers included:

Studies and Analyses Center and Science and Technology Policy Institute

Dr. Jessica Matthews
Carnegie Endowment for International Peace
"Global Warming and Non-Proliferation"

Professor Martin Feldstein
Harvard University and the National Bureau of Economic Research
"Decline of the U.S. Dollar"

Ms. Ellen Laipson
Henry L. Stimson Center
"Geo-Political Challenges for the Next Administration"

VADM John Michael "Mike" McConnell
Director of National Intelligence
"Transforming Intelligence in a Rapidly Changing World"

The Honorable Gordon England
Deputy Secretary of Defense
"Defense Overview"

Admiral Timothy Keating
Commander, U.S. Pacific Command
"Around the Pacific Command AOR"

Center for Communications and Computing

Dr. George Cybenko
Dartmouth College
"Learning Hidden Markow Models Using Non-Negative Factorization"

Dr. Robin Pemantle
University of Pennsylvania
"An Upper Bound on the Time to Obtain a Subproduct in Pomerance's Model for Quadratic Sieving"

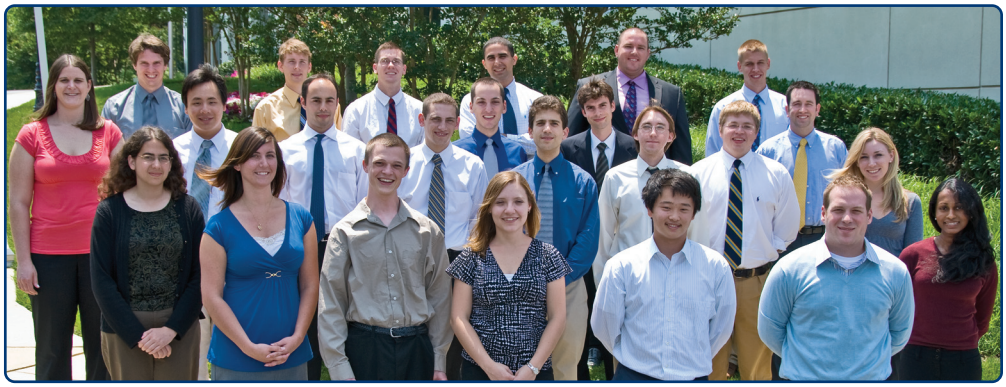
Dr. Allen Knutson
Cornell University
"Matrices"

Dr. Alan Reid
University of Texas at Austin
"Expander Graphs and the Topology of Hyperbolic 3-manifolds"

Dr. Neil Sloane
AT&T Shannon Labs
"The On-Line Encyclopedia of Integer Sequences or Confessions of a Sequence Addict"

IDA also offers a summer internship program for graduate and undergraduate students. The interns work with research staff members at IDA's Studies and Analyses Center in Alexandria and its Science Technology and Policy Institute in Washington, DC. In addition to their research activities, interns participate in educational events that include an introduction to IDA and to DoD as well as a trip to the Pentagon.

IDA's Summer Internship Program



The 2008 summer interns worked at the IDA Studies and Analyses Center and the Science and Technology Policy Institute.

IDA staff members volunteer in a variety of capacities inside and outside the classrooms at local schools, mentoring and tutoring students at all grade levels, serving as judges at science fairs, and providing insights into various career paths for math and science students.

IDA Volunteer Initiatives Include Our Annual Science Night

IDA staff members watch as a student demonstrates the power requirements of different electric bulbs with a bicycle-generator.

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- Defense Intelligence Agency
- Defense Logistics Agency
- Defense Security Cooperation Agency
- Defense Threat Reduction Agency
- Missile Defense Agency
- National Geospatial-Intelligence Agency
- National Security Agency

Joint Program Offices and Other Joint Activities

- Joint Improvised Explosive Device Defeat Organization
- Joint Program Office for Chemical and Biological Defense
- Joint Strike Fighter Program Office

Additional Government Agencies

- Central Intelligence Agency
- Delaware River Maritime Enterprise Council
- Department of Health and Human Services
- Department of Homeland Security
- Department of State
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