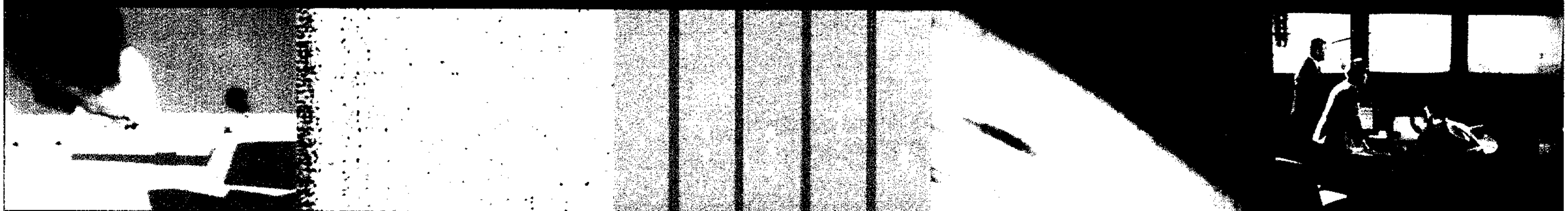
SYSTEMS EVALUATIONS

TECHNOLOGY ASSESSMENTS



RESOURCE AND SUPPORT ANALYSES

FORCE AND STRATEGY ASSESSMENTS

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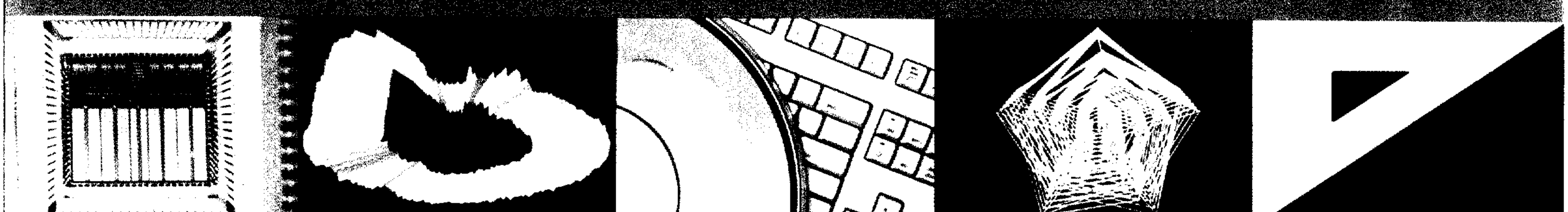

Annual Report 1995

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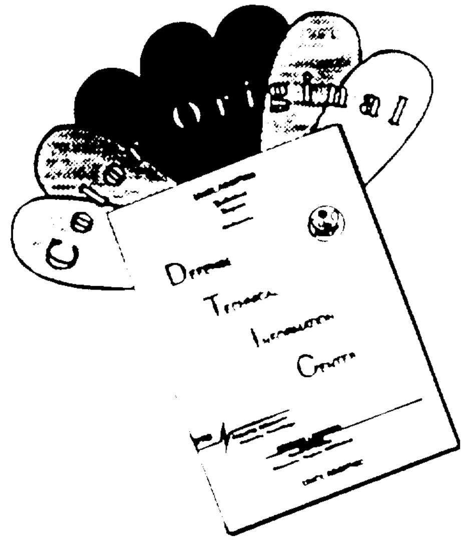

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IDA is a federally funded research and development center whose primary mission is to assist the Office of the Secretary of Defense, the Joint Staff, the Unified Commands and Defense Agencies in addressing important national security issues, particularly those requiring scientific and technical expertise.

Message From the President

Our national security leaders face an unprecedented and increasingly complex set of challenges —

- understanding and responding to a rapidly changing, ever more complex, set of players, conditions and expectations on both the domestic and the world scene;
- downsizing military forces in response to differing threats and intense budget pressures, while assuring robust military support of national security needs;
- restructuring and modernizing military forces, concepts and plans to meet 21st century needs while maintaining readiness to respond to daily 20th century demands; and
- ensuring that U.S. forces retain technological superiority in weapons while applying advanced technologies to lower acquisition and support costs.

This range of challenges calls for extraordinary attention to balancing complex, frequently competing demands. The challenges facing IDA also call for extraordinary attention to balance, both in our analyses and in our business.

Analytically, we have faced the challenge of breaking out of intellectual paradigms developed in response to the Cold War, while heeding the lessons of the past. We have refocused our efforts in new areas of concern to the national security community within our areas of core competency, while building on the basics that make IDA singular.

Our business strategy also has been challenged. As the national security budget declined over the past decade, many companies that supported DoD elected to diversify into new areas. We have chosen to stick to our core business. Our most basic, compelling and overriding analytic and business objective is to support the DoD decision process with objective, timely, high quality analysis across the full spectrum of IDA's core competencies.

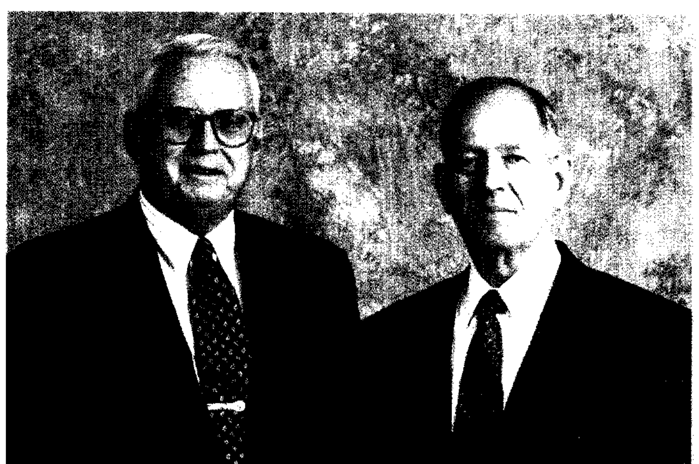
In the midst of this change, and the challenge of further change, we also remain focused on the constants that have made and will continue to make IDA a unique and powerful help to our sponsors:

- The strength and the value of IDA come from the quality and dedication of our researchers.
- The support of the IDA Trustees, IDA management, and every member of the IDA professional and support staffs nurtures the research environment and enables and enhances the effectiveness of our researchers.
- The commitment of our sponsors, at times in the face of criticism from some members of Congress and the for-profit service industry, is essential to the continuing effectiveness of IDA.

We are in the business of helping sponsors make difficult decisions. We excel in that business. To continue to excel, we are committed to keeping IDA a healthy and vibrant institution that is constantly growing in quality and focused on the customers' needs. This is the commitment of everyone at IDA, and maintaining this commitment is what assures that IDA will continue as an essential contributor to maintaining our national security.

Larry D Welch

General Larry D. Welch, USAF (Ret)
President



Larry D. Welch, President (right) and W. Jarvis Moody, Chairman

Research Overview

The research of IDA's two FFRDCs is consistent with their mission, purpose and capabilities; with DoD's needs for the core competencies they maintain; and with the special relationship between an FFRDC and its sponsors. Selected studies drawn from research within IDA's five core competencies — Systems Evaluations; Technology Assessments; Resource and Support Analyses; Force and Strategy Assessments; and High Performance Computing and Communications — are presented in the following pages.

Systems Evaluations

IDA maintains expertise in the systems of all Services, covering strategic systems and missile defenses; tactical systems for land, naval, and air warfare; mobility systems; command, control, communications, and intelligence systems; surveillance and space systems; and information and computing systems. IDA systems evaluations cover all stages of development and deployment, including test and evaluation. The analyses typically support performance development or acquisition decisions, and involve assessing system performance under a variety of conditions. Related issues of technological risk and cost also are addressed. To enhance our ability to conduct systems evaluations, IDA maintains a diverse set of modern computer tools extending from one-on-one engagement models to large-scale campaign models.

Strategic Systems and Missile Defense

Theater Missile Defense Cost and Effectiveness
The Department of Defense must decide which theater missile defense systems to acquire. The Services have proposed several options. The Army plans to upgrade the Patriot surface-to-air missile system and, early in the next decade, to develop a new mobile system to replace at least some Patriots. The Army also is developing a theater high-altitude area defense (THAAD) system, which will incorporate a new missile with an infrared seeker and a new ground-based radar. The Navy is developing missile defenses using cruiser and destroyer vertical launch systems and Aegis radars. The Navy systems would provide a low-altitude defense capability against cruise missiles and an exo-atmospheric defense against ballistic missiles. The Air Force has three candidate systems: a space-based laser, an airborne laser, and missile interceptors launched from fighter aircraft.

The challenge of prioritizing and selecting systems to develop and field is complicated because each of these systems provides unique capabilities, yet none alone provides all the capabilities needed for effective theater missile defense. To help sort out these issues, the Ballistic Missile Defense Organization is conducting a cost and operational effectiveness analysis (COEA) for all theater missile defense options. IDA is providing an independent review of the COEA to help ensure that the analysis is complete and objective. We also are conducting additional analyses to test the sensitivity of selected COEA results.

Theater Missile Defense Performance Analyses
In addition to reviewing the theater missile defense COEA, IDA is assessing other issues related to the performance of theater missile defenses. Among them are: deployability into theater; geographical area defended by the system; expected system capabilities against various threats; and the system's susceptibility to countermeasures.

To date, several IDA findings have influenced DoD decisions regarding missile defense systems. The assessed performance of some missile defense systems decreases significantly with reasonable changes in assumptions about key technical and threat parameters. Some specified levels of performance add little to overall system capability, while others come at an extraordinarily high cost.

Patriot Upgrade
Continuing modernization of the Army's Patriot surface-to-air missile system is an important part of DoD's program to counter tactical ballistic missiles. In 1994, the Army announced that it would employ a hit-to-kill interceptor in its next generation Patriot PAC 3 missile. Although this target kill mechanism differs significantly from the traditional blast-fragmentation warhead used in the current version of Patriot, an IDA-led risk assessment concluded that the hit-to-kill approach offered enough potential advantages to merit further development.

When the Navy recently selected a blast-fragmentation warhead for the anti-tactical ballistic missile version of its Standard missile, IDA was asked to reconvene the PAC 3 assessment panel and conduct an independent review of the Navy's approach. In light of the Navy's requirements for a near term overall defense capability, the review endorsed the Navy's proposed solution but also recommended several modifications to the development program.

Strategic and Tactical Systems

Heavy Bomber Forces
A key issue facing DoD is whether to buy more than the 20 B-2 bombers previously approved. To aid in making this decision, Congress directed a bomber force requirements and cost-effectiveness study; the Department turned to IDA.

As directed in the law, the study examined the contributions of alternative bomber forces in the scenario of two nearly simultaneous major regional contingencies set in the years 1998, 2006, and 2014. Five alternative bomber forces, comprising mixes of B-1s, B-2s and B-52s and ranging in size from 115 aircraft to more than 200, were compared in the study. Three of the forces included only the currently planned force of 20 B-2s; two included 20 additional B-2s. IDA analyzed the cost and warfighting capabilities of these alternative forces.

Inevitable uncertainties associated with the analysis of such a complex issue mean that extensive sensitivity analyses are necessary to ensure a robust evaluation. The IDA study included variations in scenario conditions, threat capabilities, and other parameters. The work indicated that bombers are an important element of the U.S. force structure, and that their contributions are greatest during the early phases of conflict before other U.S. forces can be deployed fully. However, the study also found that to realize the full potential of the bomber force, the B-1s and B-2s should be upgraded to improve their conventional combat capabilities. Moreover, buying additional quantities of advanced weapons would be more effective and less costly than the purchase of additional B-2s.

Our results weighed heavily in the Congressional deliberations of the FY 1996 defense authorization and appropriations bills. Although Congress ultimately voted to include additional B-2 funding, IDA's findings were cited as a basis for increasing funding for precision guided munitions. Subsequently, the President decided that he would not include funds to buy more B-2s in the FY 1997 DoD budget request.

Airborne Tankers

Airborne tankers extend the range of bombers, transports and tactical aircraft of the Air Force, Navy and Marine Corps. The current tanker fleet consists of a mix of KC-10s, KC-135s, and KC-130s. The size of the force was strongly driven by the need to support the nation's strategic bomber force. As this mission's demands have declined with the end of the Cold War, questions have arisen as to whether the tanker fleet is properly matched to DoD's regional conflict requirements and the need to support a variety of peacetime operations.

IDA was asked to provide an independent review of future airborne tanker needs. The study had two objectives: (1) to determine the size of the tanker fleet required to meet future airborne tanker requirements, and (2) to assess how the required fleet size would change if various proposed modifications were implemented. Our analyses found that the planned tanker fleet would be somewhat larger than needed for two nearly simultaneous regional conflicts, thereby freeing some tankers to be reassigned as cargo airlifters. The study also concluded that certain modifications, such as installing an additional refueling pod on some KC-135s so that two Navy aircraft could be refueled at once, would enhance joint interoperability and could ease congestion in airspace-limited areas.

Ship Acquisition

Since the early 1980s, the major U.S. shipyards have depended on Navy ship construction for the bulk of their business. In recent years, however, the Navy's need for new ships has diminished and, in response, the size of the U.S. shipbuilding industry has decreased. Additional reductions appear likely as the major yards complete the ship orders they now have on backlog.

In October 1993, President Clinton established the National Shipbuilding Initiative to help maintain the viability of the U.S. shipbuilding industry by improving the shipyards' ability to build commercial ships. Under this initiative, the Defense Advanced Research Projects Agency, through its MARITECH program, provides matching funds for shipyard innovations in commercial shipbuilding. A variety of other efforts aimed at enhancing productivity in the U.S. shipyards are under way within the Government and industry. By ensuring that Navy ship acquisition is integrated fully with these initiatives, the Government can make the best use of its declining shipbuilding funds.

To help accomplish this objective, IDA examined options for enhancing the ship acquisition process. Our efforts helped identify methods to improve

Navy acquisition, development, and construction of new ships. Particular attention was focused on acquisition strategies and program management, ship design and production practices, and the potential implications of increased commercial construction on Navy ship acquisition.

Nonacoustic Systems for Detecting Submarines
The antisubmarine warfare forces the United States deployed during the Cold War were designed to counter the Soviet nuclear submarine fleet operating in deep water far from land. These forces are somewhat less well equipped to deal with the diesel submarines that could be encountered in a regional conflict along the ocean littoral. The acoustic detection systems on which the Navy currently relies provide only limited capability against small, quiet submarines operating in shallow water.

In recent years, a number of studies have shown that a combination of acoustic and nonacoustic submarine detection systems could provide a more effective capability against these types of threats. As a consequence, DoD, through its Advanced Sensor Application Program, is pursuing development of nonacoustic submarine detection systems. To help focus the program's activities, IDA identified the most important operational characteristics for regional conflict scenarios and assessed their implications for technology development. Our findings will help guide the Department's investment decisions in nonacoustic detection technologies.

Countering Land Mines
Because modern land mines now available on the world market have little or no metallic content, the conventional magnetic mine detection systems used by U.S. ground combat forces cannot find them. As part of the Countermine Advanced Concept Technology Demonstration program, DoD is investigating alternative mine detection systems that rely on other types of sensors to detect mines. Among the options being investigated are ground-penetrating radar, seismic sensors, thermal imaging systems, and chemical mine detection systems.

In support of this effort, IDA developed measures of effectiveness for mine detection systems and assessed the state-of-the-art of mine-hunting sensors that can detect the gaseous emissions produced by the mine's explosive warhead. We also have been instrumental in working with DoD to establish a number of cooperative programs involving the United States, Canada, Great Britain, Australia, and New Zealand.

C^3, Surveillance, and Space Systems

C^4I for the Atlantic Command
As the number and complexity of the systems used to support command, control, communications, computers, and intelligence (C^4I) activities increase, integrating these systems becomes increasingly important. The need for integration plans is particularly important to the major Unified Commands, given the variety of existing and planned C^4I systems that these Commands are expected to employ and the broad scope of their operational needs. Consequently, IDA is developing the C^4I support plan for the U.S. Atlantic Command (USACOM).

In support of USACOM's integration effort, IDA's proposed communications support plan lays out a strategy for integrating the Command's existing and planned communications systems and satisfies USACOM's long-term objectives. The plan is approached from both the technology and management perspectives to enable USACOM to better prioritize, coordinate, and integrate its communications systems. The plan also includes a roadmap that integrates local and wide-area multimedia networking so that needed capabilities are provided whether the Command elements are at their stateside bases or forward deployed.

Sensor-to-Shooter Technologies
A continuing DoD goal is improving collection systems, processes, and communications to provide targeting information directly from detection sensors to the shooters that deliver weapons. Several Advanced Concept Technology Demonstration programs have been established to assess the feasibility of improving target detection,

geolocation, and data dissemination capabilities by integrating national and tactical sensor systems.

IDA provided analytical support for a technology demonstration dealing with the Precision Signal Intelligence Targeting System. During the first phase of this effort, DoD conducted two limited demonstrations using a combination of national technical means and tactical airborne systems, and some newly developed software. The demonstrations showed that such a system could significantly improve the accuracy of emitter location. Analysis is now under way to examine how this capability could be integrated with other systems in support of tactical operations.

Information and Computing Systems

Computer Security

As part of its assigned responsibility for DoD computer security, the National Security Agency (NSA) evaluates selected government and commercial software and hardware products and systems to determine their suitability. Among the most important of these evaluations are assessments of the technical protection capabilities of industry- and Government-developed products and systems conducted as part of NSA's Trusted Product Evaluation Program.

IDA assists NSA in developing the evaluation criteria used to determine whether a system is secure, and in applying these criteria to currently available computer systems, subsystems, networks, and database management systems. Part of this effort involves developing a product rating maintenance program, and providing guidelines for industry in its development of secure computer system technology.

Automated Systems for Transportation Management

The DoD transportation community relies heavily on automated information systems. Integrating these systems within an overall system architecture has proved difficult. The United States Transportation Command and the Defense Information Systems Agency asked IDA to develop and assess alternative strategies to guide the migration of automated transportation systems to standard DoD information systems.

One of the most important systems is the Joint Air Logistics Information System, which supports scheduling for DoD's fleet of 550 small turboprop and jet aircraft. The planes carry up to 20 passengers each and are typically used to meet Service transportation needs. Each Service operates and schedules its own aircraft.

Congress directed DoD to consider several changes to the support airlift fleet that would affect scheduling, modernization, size, and funding. The U.S. Transportation Command asked IDA to assess the impact of implementing consolidated scheduling of the fleet and reducing the number of planes and flying hours. As part of this effort, we are conducting a short-term review using the specific scheduling procedures proposed for each of the alternative schemes. The results of this study will help determine how the future support airlift fleet should be operated.

Test and Evaluation

IDA provides primary analytical support to the Office of the Director, Operational Test and Evaluation (DOT&E), which is responsible for reporting to the Office of the Secretary of Defense and the Congress on the operational effectiveness, operational suitability, vulnerability, lethality, and adequacy of testing of systems under its oversight. We also provide analytical support for developmental testing, and for joint test and evaluation, to the Office of the Director, Test Systems Engineering and Evaluation.

Land Warfare

IDA participated extensively in the operational testing of the Longbow Apache helicopter. We helped design the test events, assisted in the verification and validation of test instrumentation, monitored all testing, and prepared an evaluation that was a major input to the report submitted by DOT&E. IDA also developed operational test visualization software that has been used by the Army to help authenticate test trials and analyze results.

During the past year, IDA prepared an independent analysis of the Army's Forward Area Air Defense Command and Control system operational test. The analysis highlighted a fratricide problem for ground-based air defense units caused in part by continued use of visual aircraft identification. The testing showed that, when the system transmitted timely and useful information to gunners, it significantly reduced fratricide.

Naval Warfare
The Institute supported DOT&E in its assessment of a number of new ships, submarines, and naval weapons systems. These efforts included pre-test analysis, test monitoring and independent analysis of test results, construction of baseline performance databases, test design suggestions to reduce costs, and assistance in threat surrogate validation.

We monitored the operational test of the improved Mk 48 Advanced Capability torpedo. In addition to on-site monitoring, we created a database for torpedo firings, which we used to estimate current torpedo performance in a variety of scenarios.

IDA monitored, analyzed, and reported on tests of the Standard Missile 2 upgrade and Sparrow AIM/RIM-7R air defense missiles. These assessments were based on a combination of flight tests, modeling and simulation. As part of this effort, IDA participated in the Navy's validation of the Vandal target as a surrogate for Sparrow's "Prime Threat." This was the first time that the Navy validated a target; it will be used as a model for future target validations.

Air Warfare
The C-17 airlifter completed its initial operational testing this year. In addition to the completion of extensive testing for the operational effectiveness evaluation, an intense twelve-aircraft, 30-day reliability, maintainability, and availability evaluation was conducted as part of the operational suitability evaluation. IDA's independent analysis of the C-17's performance was a major element underlying DOT&E's assessment reports.

We continued our test planning support for the F-22 advanced tactical fighter. We developed an appropriate set of measures of effectiveness for evaluating the F-22 and continued to emphasize the importance of a comprehensive operational suitability test, including an early demonstration of the F-22's surge capability.

IDA analysts observed testing of V-22 tilt-rotor aircraft prototypes, focusing on rotor downwash effects on the aircraft's ability to conduct tactical and special operations. For the F/A-18 E/F aircraft, we observed the Navy's conduct of missions using the contractor's manned air combat simulator. This will assist in defining the significant characteristics and capabilities that must be confirmed via OT&E.

Strategic Warfare
Before upgrading the B-1B's conventional weapon capabilities, the Congress sought assurance that the aircraft was sufficiently reliable and supportable. The Operational Readiness Assessment, which was designed to measure B-1B reliability, maintainability, and sortie generation rates over a six-month period, concluded with a simulated combat deployment. IDA was integrally involved in planning the assessment and closely monitored activities and data collection. Our analysis of the data confirmed that it was a rigorous test and that the mission-capable rate exceeded the goal.

Command, Control, Communications, and Intelligence (C^3I) and Computer Systems
The Radar System Improvement Program upgrade for both the U.S. and NATO E-3 Airborne Warning and Control System underwent operational testing in 1995. IDA collected the baseline performance data, monitored the operational testing, and is analyzing the data. We also monitored testing and reported on an upgrade for the Navy's E-6A TACAMO aircraft

and the Army's Joint Tactical Distribution System Class 2M terminals. IDA monitored the 1995 All Service Combat Identification Evaluation Test, primarily to identify the current Mark XII identification system baseline.

More than 30 programs — representing a broad range of DoD's computer-based systems that provide administrative, logistical, maintenance, and strategic planning support — are being reviewed by DOT&E. In 1995, IDA analysts supported DOT&E in the analyses of operational test materials, execution, and results for 14 of these.

For example, in 1995 the Global Command and Control System (GCCS) matured from a demonstration project into a major program. GCCS will replace the aging World Wide Military Command and Control System. Our assessments showed that operationally essential needs were not being addressed in the GCCS implementation, needs such as sufficient operating policies and procedures, network load management, comprehensive threat assessment, and trustworthy database and system recovery processes. Our participation led to the evolution of a more coherent test strategy for GCCS.

Electronic Warfare

IDA completed an initial evaluation of the F-15E Tactical Electronic Warfare System operational assessment done in 1994. IDA's analyses uncovered radar warning receiver problems previously undetected. Analysis of the jammer component of the test indicated a wide disparity between the conditions of the test sorties and expected F-15E operational employment. Examination of a large suitability database also revealed significant problems consistent with a pervasive problem in fielded electronic warfare system suitability.

Live Fire Test and Evaluation

Live Fire Test and Evaluation (LFT&E) is used to assess both the vulnerability of U. S. weapons systems — with particular attention to minimizing personnel casualties — and the lethality of munitions and missiles. These programs place special emphasis on test realism and the assessment of results in an operational context. As a result of 1994 legislation, DOT&E is now responsible for oversight of LFT&E, and results are being integrated with OT&E results in the DOT&E reports required by the Congress.

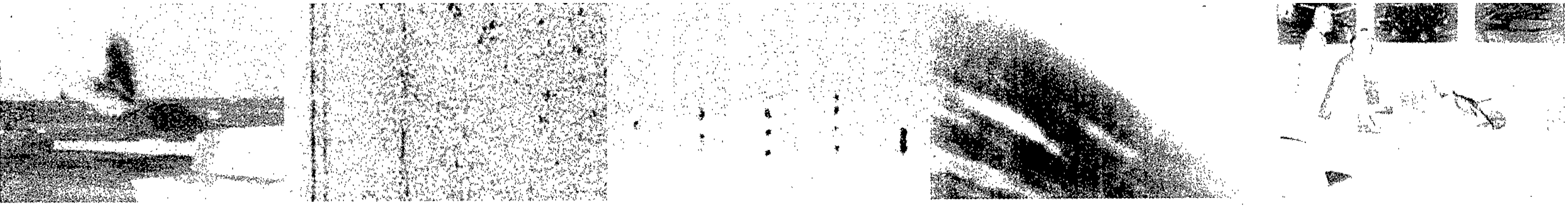
This year, IDA supported DOT&E by defining the characteristics of acceptable test and evaluation, by reviewing more than 40 programs, and by preparing independent assessments for four completed test programs: the Longbow Apache AH-64D, Longbow Hellfire missile, C-17 transport aircraft, and a 50 caliber cartridge. The C-17 and the Longbow Apache were the first aircraft programs to complete live fire test and evaluation and were the culmination of several years of analytical activity by IDA.

Joint Test and Evaluation

During 1995, IDA completed its evaluation of the Joint Air Defense Operations (JADO) joint test. IDA hosted a C^3I workshop to develop an implementation plan to execute the JADO findings. JADO has become a model for the future joint tests. IDA monitored the progress of the Joint Advanced Distributed Simulation joint test, which was initiated in 1995. IDA provided assessments of the Joint Combat Search and Rescue (JCSAR) and Joint Operations and Intelligence Network (JOIN) feasibility studies, which have resulted in chartering of the JCSAR joint test. IDA continued to monitor JOIN and has taken on the independent assessment task on the Joint Suppression of Enemy Air Defense feasibility study.

Developmental Test and Evaluation

In 1995, we revised a handbook containing embedded software risk indicators. We also completed the identification of risk indicators for advanced sensor systems — specifically those using thermal imaging technology — as well as risk indicators for general processes used in the development, testing, and manufacturing of hardware systems. These indicators were compiled in a handbook for use by DoD acquisition officials and distributed to offices within OSD, the Service acquisition and test communities, and the Program Executive Officers. The utility of this handbook will be evaluated by applying it to the Joint Standoff Weapon program.



Technology Assessments

IDA provides scientific, technical, and analytical support related to identifying, developing, and using advanced technologies for defense systems. This work involves assessments of technology feasibility, performance, producibility, demonstrations, and development risks. Areas in which IDA has special expertise include sensors, surveillance, and target acquisition; materials; simulation and training systems; space, air, and missile systems; manufacturing and test processes; and information and computing. IDA also assists DoD in developing technology strategies, plans, standards, and investment priorities.

Sensors, Surveillance, and Target Acquisition

Sensors for Open Skies
The goal of the Open Skies Treaty is to build confidence among member countries by providing information on the intentions and military preparedness of other treaty member countries. There currently are 27 signatories to the Treaty, including most of the NATO and former Warsaw Pact nations. Open Skies uses reduced-capability sensors and host country monitoring to guard against the loss of vital state secrets, while providing enough information to assure other nations of the observed nation's intentions. Over the last year, IDA has provided analyses critical to negotiations regarding sensor selection, sensor sensitivity and resolution, and search procedures.

IDA examined the extensive U.S. database on the performance of U.S. cameras to determine the reliability of the methods adopted by the Open Skies community for verifying sensor capabilities. Our purpose was not only to establish a U.S. baseline, but also to provide a basis for the U.S. negotiating position. We concluded that the Open Skies methodology would provide a reasonably accurate representation of the cameras studied — the scientifically based requirements are strict enough to guard against cheating and flexible enough to allow for the vagaries of relatively uncontrolled flight tests. This work was subsequently used to inform U.S. delegations in Vienna and has been instrumental in bolstering confidence among the signatories.

Infrared Search and Track Systems for Ships
Infrared Search and Track (IRST) systems can provide stealthy detection of airborne threats, either aircraft or cruise missiles. The development of IRST systems for ships requires the solution of a number of fundamental problems, one such problem being the choice of the optimum infrared waveband for ship-based IRST. Although a consensus has evolved regarding the optimum waveband to use for airborne IRST, the issues for the ship-based systems are more complex. IDA helped clarify the choices for a ship-based IRST, taking account of target signatures, average atmospheric conditions, and weather variability.

The study of waveband choice highlighted two primary conclusions. First, although a single waveband would optimize results under most conditions, unique geographical conditions might still point to the need for a dual-waveband system. Second, the actual performance of an IRST system will vary with atmospheric conditions. A proper understanding of the performance requires a careful use of atmospheric models and appropriate application of insights gained from studies of atmospheric availability.

Infrared Scene Simulations
The use of simulation is increasing in defense applications, in part to replace impractical or expensive field tests, and in part to shorten the acquisition cycle. An open question has been the fidelity required of simulations of sensor outputs, in particular imagery, if reasonable conclusions are to be drawn from simulation studies.

IDA is addressing this question in the context of ship defense against cruise missiles. The Infrared Analysis Measurements and Modeling Program has developed background clutter simulators for IRST applications that include scene simulators for clouds and the ocean surface. Actual scenes were matched with simulated scenes. Point targets representing incoming cruise missiles were inserted into the real and simulated scenes. Typical signal processing algorithms were applied to both, and the performance was measured in both the real and the simulated scenes. In several cases, the simulation did remarkably well. In others, the analysis revealed shortcomings of the simulation models.

Foliage-Penetrating Radar
Military operations involving U.S. troops must be prosecuted and completed at minimum cost in terms of troop force deployments, time, and casualties. This places a premium on the ability to rapidly locate and target the enemy's most threatening weapons, including theater ballistic

and cruise missiles as well as other advanced weapons. U.S. forces can destroy most targets once detected and are rapidly improving detection capabilities in open terrain. Nevertheless, the ability of an enemy to exploit foliage and tree canopy to conceal weapons within range of U.S. troop deployments remains a cause of serious concern to U.S. commanders.

One promising solution to the problem of detecting concealed weapons is exploiting radars operating at frequencies in the VHF band commonly used for radio and television communications. Radars at these frequencies are able to penetrate tree canopies and, when used in synthetic aperture radar (SAR) systems, can provide radar images with useful resolution.

Over the past several years, IDA's findings have included both specific and general insights. Namely, our analyses determined that the key to exploiting the penetration capability of VHF is developing an airborne ultra-wideband SAR. Toward achieving this end, IDA identified three key enabling technologies, all of which are now the subject of current DARPA programs. These include the "cohabitation" of the radar with existing radio services in the densely used VHF band; high-power computing systems and algorithms to perform image processing in real-time; and rapid automatic target detection algorithms capable of processing the large volume of imagery expected from searching large areas using penetrating SAR radar.

Space, Air, and Missile Technologies

Cruise Missile Defense

A major advance in cruise missile defense is technologically possible through the introduction of an elevated platform using advanced sensor designs. Advanced airborne sensors would permit a surface-to-air missile (SAM) to engage targets over longer ranges. However, the choice of platform and the best combination of sensor attributes depend on how the new concept will be merged into the existing framework of U.S. air defenses. Potentially, this addition of an advanced capability platform could affect the missions, roles and responsibilities of air defense units across the Services. Thus, the best suite of technological options cannot be determined without in-depth evaluation of the impact of those choices on operations. IDA's approach to this evaluation includes the use of force-on-force engagement simulations.

The first round of modeling indicated that the addition of advanced airborne sensors would enable surface-based SAMs to engage cruise missiles more effectively, pushing the engagement zone to the outer fringes of the battle space. This would free up air-to-air fighters for other missions and provide a clearer air picture to close-in point defense systems.

Missile Phenomenology

Central to defeating enemy missile attacks is understanding what the target looks like, how it moves, and its interaction with the environment. These are all aspects of phenomenology — a broad discipline in which IDA is recognized as a national leader. IDA has developed a phenomenology group that comprises experts in sensor technology, target and background signatures, and atmospheric effects.

IDA's research in phenomenology includes studying the chemistry and physics of rocket exhausts, emissions from aerothermally heated missile bodies, spatial clutter and noise contributed by the earth, and effects on the target signature arising from interaction with the atmosphere. Our team of experts validates theoretical phenomenology models that are then used by system engineers to ensure that the next generation of defensive systems meet their operational goals. In addition to advancing the theoretical understanding of these issues, we also are heavily involved in the experimental design and analysis of data to support the development of models and theories. Serving as principal investigators for several DoD observatories, instrumented aircraft, and satellites, our scientists provide technical analyses to ensure that the necessary data are collected, processed, and analyzed.

IDA also leverages the experience gained in military phenomenology by applying our expertise to similar problems in the non-defense remote sensing community. For example, we provide assessments of the technical risks associated with NASA civilian space missions. Through our involvement with similar DoD missions, we are able to provide unique perspectives on mission risks.

Materials

Individual Protection for Soldiers
Military missions such as peacekeeping and operations in urban areas may involve situations where conventional rules of engagement do not apply. Threats to the soldier may be dominated by small arms rather than fragmentation weapons. These operations have parallels with domestic law enforcement activities. Both military and law enforcement personnel need protective equipment tailored to specific threats. IDA is working with DARPA to choose and develop materials to provide enhanced protection with minimal effects on soldier mobility. For example, DARPA is examining hard body armor inserts that could provide armor piercing protection with lighter weight than current systems. Also, new efforts are under way to examine enhanced head and extremity protection, and enhanced protection for covert body armors.

Manufacturing of Advanced Materials
IDA participated in an assessment of the U.S. industrial base for advanced defense-related materials. Our analysts led teams that assessed the status of industries that produce titanium, beryllium, superalloy, advanced polymer composites, metal matrix composites, ceramic matrix composites, and high thermal conductivity composites. The primary conclusion was that DoD is not currently in danger of losing access to any of these technologies.

Concern about the stability of the advanced materials industrial base has been accompanied by an emphasis on affordability. In that regard, IDA assessed the manufacturing technologies used in the fabrication of components from advanced composites. During FY95, for example, IDA led a workshop on closed-mold manufacturing of advanced polymer missile system composites. The workshop specifically focused on understanding the user requirements and examined the technical issues associated with several closed-mold manufacturing processes. The results from this workshop provided comparative data on material availability, quality, and reproducibility and formed the basis for developing integrated product designs that will provide improved system performance and reduced acquisition costs.

Electronic Materials for Infrared Systems
The performance of optoelectronic devices is determined by their architectural design and by the properties of the materials from which they have been fabricated. In passive devices, such as infrared detectors, defects in the crystal structure adversely affect detector sensitivity. In addition, variations across the detector array make it difficult to interpret the output of an infrared array. Owing to the complexity and urgency associated with producing good detector material, IDA provides continuing technical assistance to DARPA in assessing the viability of material production techniques and the competency of suppliers of infrared materials.

Computer and Information Technologies

Information Systems Architectures
Increasing needs for interoperability among diverse DoD information systems has led to interest in common architectures. Information systems architectures provide frameworks of standards, guidance, components, and structure that enable differing systems to interoperate effectively.

A key element of mission effectiveness in any joint operation is the ability to exchange information rapidly and accurately among air, ground, and sea forces. In support of the Defense Information Systems Agency, IDA developed the architectural design for the Common Operating Environment of the Global Command and Control System

(GCCS). The GCCS will be the primary joint command, control, communications, computer, and intelligence system for DoD, replacing a collection of separate, non-interoperable information systems that resided on different hardware platforms with specialized operating systems. With the Common Operating Environment, interoperability is enhanced through services such as data management and distributed computing, and common support applications such as message processing and mapping services.

Security of National Information Resources
Information superiority, facilitated by advanced computing and networking, is revolutionizing DoD's integrated warfighting capability. The technology, however, also introduces new vulnerabilities, and protection must be incorporated as an integral part of advanced computing and networking capabilities. IDA is examining ways to enhance the security of national information resources. In the past year, these activities have included assistance to DARPA in establishing an Information Survivability Program, and support to the National Security Agency in developing Federal criteria for information security.

Computer Programming Languages
Twenty years ago, IDA participated with DARPA, OSD, and the Services in developing requirements for a new programming language that could lead to a reduction in the number of languages used in weapon systems — then estimated at 400. Recently, the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence commissioned a study to determine the number of languages now being used.

We surveyed weapon systems with software-intensive components and major automated information systems, and found over 80 percent of new or modified systems are written in third generation languages. Thirty-seven languages are used, but only three (Ada, C, and Fortran) account for well over half the sample for weapons systems, and two (Cobol and Ada) account for most automated information systems. Considerable progress has been made since in reducing the number of languages that DoD must maintain; however, a substantial fraction of applications use older versions of programming languages, as well as vendor-unique and military-defined languages. Our findings lend support to efforts aimed at modernizing DoD application systems.

High Performance Computing (HPC)
Congress mandated that the Secretary of Defense develop a supercomputer modernization plan. The ultimate vision is to ensure that DoD's high performance computing and communications capabilities are state of the art. The belief is that this capability is important to the ability of the U.S. to maintain its technology supremacy in weapon system design and to foster the flow of this technology into warfighting support systems.

IDA is a key player in a requirements analysis working group established to identify present and future HPC requirements. As part of this effort, IDA has identified 2,870 users in nearly 400 computational user groups across the United States. Only one-third of the computational needs of these users are currently being met. This analysis has prompted a major acquisition to procure additional resources.

Manufacturing

Manufacturing, viewed in the broadest sense, refers not just to factory floor production, but rather to the whole cycle of design, production, and maintenance, and involves business as well as technical processes. IDA research pertains to this entire spectrum. Central themes in this work are reducing the cost of defense systems and making maximum feasible use of commercial practices and technology.

The Defense Manufacturing Council
The DoD created the Defense Manufacturing Council (DMC) to plan and execute an overarching strategy for efforts aimed at acquisition reform, technology insertion, modern manufacturing methods, and other activities to reduce weapon system costs. IDA's work with the DMC focuses on determining cost drivers for manufacturing, identifying strategies to

reduce these costs, and developing mechanisms to implement these strategies. Two strategies are now being implemented: (1) use of Integrated Product Process Development techniques to integrate all elements of a weapon system from the start of its program; and (2) use of the Program Executive Officers and Program Managers as the key implementors of all cost reduction strategies.

IDA currently is developing and coordinating three additional elements of the manufacturing strategy: (1) Cost As an Independent Variable (CAIV); (2) process maturation; and (3) use of "pilot" programs to implement strategies. The CAIV initiative promotes trade-offs between cost and performance, with life cycle cost considered as important as performance. Process maturation implies that only mature processes (business, design, or manufacturing) be used in the production phase of a weapon system program. Pilot programs are being initiated as implementation mechanisms for these strategies. This IDA effort is serving as a catalyst for all these continuing activities directed at an attainable reduction in the total cost of weapon systems.

Agile Manufacturing

DoD will require a very responsive industrial base as procurements are made in smaller quantities and as needs change quickly in response to new, often unanticipated threats. Agile Manufacturing is a strategy to allow the industrial base to develop capabilities to respond rapidly with high quality, affordable products. This strategy encompasses and transcends both flexible manufacturing, which allows for easily reconfigured production lines, and lean manufacturing, which minimizes resource utilization.

IDA assists DARPA in assessing the applicability of the technologies and practices of Agile Manufacturing to the production and support of products for military use. These technologies and practices will expand the availability of affordable made-to-order defense products by facilitating efficient production of varying quantities of customizable, reconfigurable, and upgradeable products. IDA is also helping develop the architecture for the Agile Manufacturing Knowledge Base that will disseminate these results over the World Wide Web. DoD will use this work to help align defense manufacturing technology investments and acquisition practices with those of commercial industry, and to improve the possibilities for rapid acquisition of high quality custom defense products from commercial manufacturers at low cost.

Electronic Commerce

Wider use of electronic commerce (EC) by DoD suppliers and their sub-tier suppliers could generate significant cost savings and other benefits to the Department. To encourage wider use of EC, DARPA's Electronic Commerce Resource Center (ECRC) program provides education, training, consultation, and technical assistance to small enterprises and their Government and prime contractor trading partners through a network of eleven centers around the United States.

IDA advises DARPA in designing, operating, and refining the ECRC program so as to ensure the best possible mix of services, consistent with users' needs. The use of Electronic Data Interchange (EDI) is the first step along a technology path that continues through technical data interchange and integration of EDI with internal systems, to the operation of a true virtual enterprise. IDA's findings can be used to support DoD efforts for acquisition reform using electronic commerce techniques.

Commercial Microelectronics

Although cost and availability factors dictate that DoD take advantage of commercial sources of microelectronic components, there are concerns about the availability of integrated circuits (ICs) to meet defense needs over the long term. On the one hand, IDA found that military specification IC suppliers have begun to drop out of the defense market; major military and commercial IC suppliers will no longer support the 10-20 year DoD system lifetimes; and DoD IC quantity requirements are insufficient to warrant special support from the commercial side of large IC suppliers. On the other hand, given proper engineering and manufacturing consideration, commercial ICs are broadly (though not completely) applicable for use in defense systems. In fact, the IDA study showed commercial ICs are already used extensively in defense applications.

Commercial industry offers not only components for use in defense electronics systems, but also manufacturing practices from which the defense sector might benefit, in terms of cost and capability. To identify such practices, IDA visited a series of commercial and defense electronics manufacturing plants. Typical defense products were found to have more stringent application-specific requirements, older technologies, and protracted development and production cycles. Potential opportunities for reducing costs and promoting modern technology included managing electronics acquisition and support at the circuit card (rather than IC) level and above, and allowing contractors to capitalize test equipment to meet a business base rather than the needs of a single weapon system program.

Technology Planning and Control

Commercial Practices

DoD's "dual-use" strategy is intended to reverse the Department's long-standing practice of relying on defense-specialized suppliers who produce items strictly to military specifications using government-dictated business practices. In June 1994, the Secretary of Defense directed the adoption of commercial practices that will allow a single base of suppliers to serve both defense and commercial markets. This strategy is intended to reduce the costs of maintaining defense-dedicated suppliers, give DoD better access to leading commercial technologies and, whenever possible, use DoD-created technologies to advance commercial product technologies and productivity.

To assist DoD in implementation, IDA examined opportunities for and barriers to this approach in specific technology areas, and identified opportunities for accessing technologies held by our allies. We also assessed the current state of the U.S. advanced materials industry in selected sectors, and recommended changes in acquisition policy that would facilitate incorporation of advanced electronics packaging technologies from the commercial sector into DoD systems.

Preventing the Export of Critical Military Technologies

The Militarily Critical Technologies List (MCTL) provides policy officials, licensing officers, technical analysts, and international negotiators with performance parameters, technical dimensions, and standardized expressions of capabilities for those technologies and items critical to national security. IDA works with OSD to create the MCTL from the technical inputs of Technology Working Groups (TWGs) chaired by IDA scientists and researchers. Members of the TWGs are experts from government, industry, and academia. In addition to preparing the document, IDA provides technical support to U.S. representatives during international negotiations.

Other Transactions

"Other Transactions" are a special form of contractual arrangement that DARPA has statutory authority under 10 USC 2371 to use with private sector R&D organizations. These agreements are more flexible and less administratively burdensome than are typical Government procurement contracts. For an impartial assessment of Other Transactions, DARPA asked IDA to survey the views of participating firms on the benefits and drawbacks of these agreements compared to traditional contracting methods.

Other Transactions typically involve consortia of companies working on an R&D project. Although some companies reported difficulties related to consortium formation and cost sharing, in general the participants found Other Transactions provided greater flexibility and efficiency and reduced administrative overhead, and allowed them an appropriate allocation of intellectual property rights. Some firms reported that they would not have participated in DoD-funded research had they been required to enter into a conventional agreement.

Simulation

DoD is encouraging the use of simulation to enhance the training and readiness of our forces and to support the acquisition of affordable, technologically superior weapons. Large-scale technology demonstration programs provide key insights into the military utility of advanced distributed simulation, while a series of basic research programs in architecture, high-capacity networks, computing, virtual environments, instrumentation, and displays improve the underlying technology. In support of DoD's programs, IDA provides independent assessments of major demonstration programs, evaluations of simulation technology, and analyses to identify the potential for new simulation applications.

Simulating Small Unit Operations
The United States must increasingly consider committing forces to early entry operations designed to preclude major regional contingencies. Some adversaries may possess sophisticated technology that could place our forces at risk. Compounding this will be deployments restricted by lift assets, in-theater infrastructure, and complex rules of engagement. To fight effectively, future forces must be lighter, more lethal, and better able to conduct dispersed operations.

Based on the Army Force XXI and Marine Corps Sea Dragon programs, DARPA characterized the key capabilities required to enable new warfighting concepts: an integrated comprehensive awareness system; robust communications useful in urban environments; and an integrated, scaleable common grid of the battlespace to aid in precision geolocation. IDA is working closely with the Defense Mapping Agency and the Topographic Engineering Center to define the specifications of a training site to serve as a testbed for military operations in urban environments. IDA will assist DARPA in the use of distributed simulation for integrated testing and evaluation of technologies that focus on enhanced situational awareness at the tactical level, wireless communication, precise geolocation and navigation systems, tactical sensors, and robotics.

Synthetic Theater of War
The DARPA Synthetic Theater of War (STOW) Program is an Advanced Concept Technology Demonstration that will apply distributed simulation to joint task force training and mission rehearsal. The Atlantic Command, the program's co-sponsor, will use the new simulation system during its United Endeavor exercise in November 1997. To accomplish this challenging objective, STOW is developing the next generation simulation technologies in real-time networks, synthetic environments and forces, exercise management, and simulation architecture.

IDA assisted DARPA in defining the program in 1992, and continues to provide independent assessments of the technology and overall program coordination, drawing on expertise company-wide. The complex and ambitious goals of the STOW program benefit from IDA's objective perspective and our ongoing analyses of the operational utility of STOW compared to traditional training programs.

IDA's Simulation Center is a valuable testbed environment for periodic proof of concept demonstrations. A major example this year was Engineering Demonstration #1, in which IDA helped evaluate new dynamic multicasting on advanced networks, weather in a synthetic environment, very high resolution terrain, and a major advance in synthetic forces research.

Simulation for Joint Countermine Demonstrations
Given the worldwide availability of mines, countermine operations are a critical element in the ability of the United States to conduct joint expeditionary warfare in littoral regions. The Joint Countermine Demonstration is designed to develop new technologies and countermine systems and to help integrate emerging joint C^4I capabilities. This program will exploit distributed interactive simulation to gain insight into the behavioral and human decision-making aspects of mine and countermine warfare.

IDA provides technical analyses for the simulation portion of the Joint Countermine Demonstration. The Institute extended the Smart Mine Simulator to create a prototype distributed interactive Comprehensive Mine Simulator, which represents both mine and countermine assets and operations. The Army Battle Lab now uses the simulator in systems evaluations.

High-Level Architecture for Simulation
DoD is developing a high-level architecture for simulation to address problems of interoperability and reuse. An initial description of the architecture was produced in March 1995, and 14 major DoD simulation programs are now developing prototypes to test and refine it. The goal of this effort is to create better joint simulations, to promote time and cost savings for developers, and to facilitate effective, wide-scale applications of simulation in DoD.

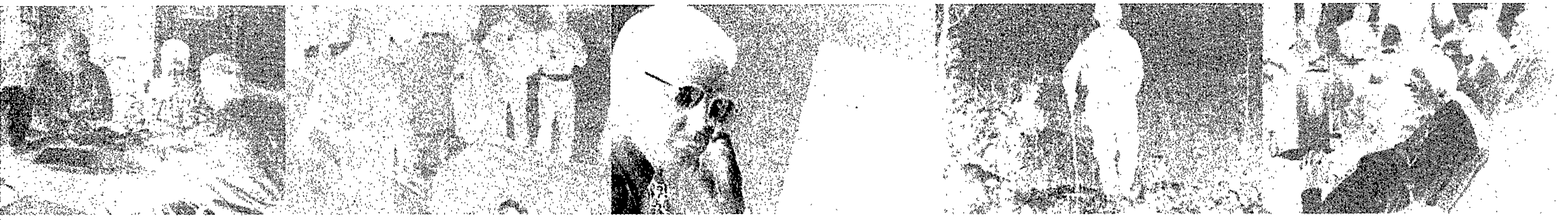
IDA has participated in the high-level architecture work since its inception in 1994. Initial efforts included reviewing and assessing alternative concepts for the architecture, and then synthesizing and augmenting these concepts to help develop the initial description of the high-level architecture. IDA work since then has focused on further definition of specific concepts (e.g., interface specification), and has involved interactions with the 14 programs testing this architecture.

Enhancing Joint Simulation Capabilities
The Joint Simulation System (JSIMS) is a major DoD initiative to improve joint readiness. Initially geared to the commander of a joint task force and the commander's staff, the complete system will be used to provide training at all joint levels and components. Guiding JSIMS development is the need to incorporate modern software techniques, new simulation technologies, and conformance to high-level architecture principles.

This year, IDA's work in this area included the development of a conceptual model of the joint mission space, using object-oriented technologies. This model will be validated and used as a specification by the JSIMS system developers. Results of this effort will be provided to the Defense Modeling and Simulation Office and will be available DoD-wide through the Modeling and Simulation Resource Repository.

Improving Classroom Education through Simulation
The Computer-Aided Education and Training Initiative is a Congressionally directed program to apply computer-aided techniques in the classroom. Recognizing the similarities between collaborative, project-based learning environments and military distributed simulation, DoD asked IDA to assess the potential for technology transfer between these programs.

IDA identified pertinent lessons from DoD's use of distributed simulation for training. These include the need to have clear educational objectives, the correct level of simulation fidelity, and measures of individual and collective performance in a virtual environment. IDA concluded that several DoD-developed software technologies are applicable for classroom distributed environments.



Resource and Support Analyses

IDA develops and improves methods for estimating the costs to develop, procure, test, operate, and support defense forces and systems. IDA also examines infrastructure and support activities including issues related to acquisition planning and resource management, training and readiness, mobilization of the industrial base, industrially funded activities, and environmental planning and technologies.

Cost Analyses

Long-Term Costs of DoD Policies and Programs
The Department of Defense uses the Defense Program Projection to assess the long-term cost consequences of current policies and programs; to forecast trends in force structure, fleet aging and obsolescence; and to identify potential resource allocation issues. The Defense Program Projection provides a broad assessment of aging and other trends to identify weaknesses in the modernization program that may require remedy. IDA has developed algorithms that are used in preparing the Defense Program Projection to determine future baseline force operating and support costs, project baseline forces, and analyze alternatives. DoD's use of these algorithms will facilitate long-range investment planning.

Costs of Replacing Aging Equipment
DoD faces a potential shortfall in resources to recapitalize aging equipment and facilities, while maintaining force structure and readiness. IDA-developed planning tools and case studies assist DoD in evaluating resource allocations and resource planning.

We develop program assessment tools and perform case studies of specific weapon systems to assist DoD in evaluating alternative recapitalization investments in equipment and facilities. Prototype tools being developed incorporate methods of evaluating risks associated with particular estimates of equipment service life and the use of service life extension programs. These initial prototype tools and case study findings will be used by DoD to help evaluate the adequacy and riskiness of current plans to replace aging equipment.

Estimating Indirect Costs
Indirect costs now represent a significant portion of contract costs. For example, recent data on aircraft manufacturers show that overhead costs typically exceed 50 percent of in-plant costs. Unlike direct costs, which usually vary with output, some indirect costs remain relatively constant over different levels of business activity. These differences in cost behavior can significantly affect unit costs and, ultimately, the contract price the government must pay.

To assist in the ongoing improvement of the Defense Department's capability to estimate contractor indirect costs, IDA has been collecting overhead and business data for nearly 15 years. The data collected thus far have been employed in two ways. First, the data were organized into standard cost and business structures to reflect accurate and consistent information used for a variety of analytical purposes. Second, the data were used to develop more reliable statistical models for estimating total overhead costs and the relative changes in those costs as business activity fluctuates.

Risk Margins in Cost Estimating
Defense contractors must assemble cost estimates from line-item managers in order to develop an overall cost estimate for manufacturing a new weapon system. Each line-item manager tends to include a margin for risk to account for factors that might drive actual cost above its expected value. However, simple aggregation of risk-corrected estimates leads to an overstatement of the risk margin required for the project as a whole. Typically, defense contractors are not aware of this possible overstatement; and even if they are aware, they may not have the necessary tools to compute the appropriate risk margins. The use of more conservative risk margins could yield potentially large savings in defense procurement.

IDA is currently evaluating alternative models that purport to estimate more appropriately the risk margins for large-scale manufacturing contracts. All aspects of the tools are being evaluated, including mathematical accuracy, ease of use, and range of capabilities. A second phase of this work will investigate applications to the defense procurement process.

Reducing DoD Costs by Leveraging Commercial Aircraft Production
In deciding the composition of future strategic airlift forces, the Defense Department considered buying commercial or non-developmental military aircraft as an alternative or supplement to additional C-17 procurement. An important factor in DoD's decision-making process was the relative costs of such alternative aircraft. To address this issue, DoD required cost and technical data, as well as interpretation of the data.

IDA obtained and assimilated cost and technical data from industry, and developed methods to assist in cost analysis of strategic airlift options. Inputs included analyses of "industry average" airlift aircraft manufacturing costs, cost experience from completed C-17 production lots, operating and support costs of existing airlift aircraft, and cost and technical risks associated with adapting commercial aircraft for the military airlift role. The resulting cost estimates were integral to the November 1995 deliberations of the Defense Acquisition Board.

Developing Resource Analysis Tools for Emerging Democracies
In August 1993, DoD initiated the Defense Resource Management program to assist emerging eastern European democracies develop the skills to manage their military establishments. The program was developed to mentor eastern Europeans in force and resource planning concepts and methods. Developed by IDA, the Defense Resource Management Model illustrates various concepts associated with defense spending and planning. To date, it has been used in Poland, Bulgaria, Romania, Hungary, and Albania.

The model is tailored to operate in terms of the command structure, personnel classifications, budget structure, and other administrative characteristics of each country. This allows the general purpose model to be tailored to correspond to each country's management techniques. The cost module produces estimates of a country's total defense budget based on its order of battle, equipment inventories, peacetime training, manning policies, major system procurement, and war reserve inventory changes. These capabilities allow each country to develop strategies to size and structure a force that can be adequately funded over the long term. Using the model's capabilities to represent fixed and variable cost relationships, countries can analyze the funding required to increase unit training levels and then compare these costs to alternatives such as equipment modernization. The program has been highly successful. Several countries are now integrating the model into their defense planning process.

Industrial Base and Mobilization

Reducing DoD Costs through Improved Stockpile Management
Innovations in information processing, manufacturing, inventory control, and resource management techniques are opening up significant possibilities for DoD in the areas of logistics and crisis sustainment. IDA's analyses and development of decision aids in this area are contributing directly to major savings and efficiencies for the Department.

Over the last several years, IDA has designed and helped implement an interdepartmental planning and modeling architecture that helps DoD develop systematic estimates of inventory requirements for the government's multi-billion dollar National Defense Stockpile. The Stockpile includes some 100 non-fuel strategic and critical materials as well as many materials with significant uses in defense systems, such as cobalt, platinum, titanium, germanium, and beryllium. IDA's work in this area has directly led to major savings, potentially exceeding $5 billion.

Now that the Stockpile modeling process is well established, IDA is addressing selective model enhancements, and is conducting special studies, such as examining ways to dispose of excess Stockpile inventories without unduly disrupting the materials markets.

Improving Industry Responsiveness During Crises
Following the Gulf War, IDA conducted in-depth assessments of crisis production constraints and possibilities. These assessments included the production of high priority weapons systems such as the Patriot Missile, as well as critical soldier support items such as boots, rations, and atropine injector kits. In addition, IDA explored methods of improving industry responsiveness during future contingencies.

For these analyses, IDA drew on the expertise and experience of senior executives representing key suppliers of equipment during Gulf War operations. IDA also looked at ways to expedite delivery of end items and repair parts and to improve DoD awareness of usable inventory locations. Electronic contracting and inventory management control mechanisms such as barcoding also were reviewed.

Acquisition Planning and Resource Management

Telecommunications
IDA has been working in support of the Defense Information Systems Agency (DISA) to find ways to reduce telecommunications infrastructure costs, streamline acquisition, and improve operating efficiency through commercial and competitive practices, commercial pricing alternatives, and information technology procurement efficiencies.

The DoD telecommunications infrastructure, which is supported through the Defense Business Operating Fund, is evolving to a modern global network with management, pricing, and service offerings similar to a commercial system. Continued pressures for these telecommunications networks and information technology to be competitive with commercial alternatives, flexible to support the warfighter, and state-of-the-art to provide new technologies compels DISA to be forward looking in planning, acquiring, implementing, operating and assessing their information infrastructure. IDA supports DISA through several studies requiring sensitive infrastructure network design plans, proprietary contract data, commercial pricing data, requirements plans, and engineering traffic data.

Training and Readiness

Resources for Readiness
Maintaining the readiness of our defense forces is a key priority of the Department of Defense. During budget deliberations, senior defense officials must be able to determine if the defense program provides adequate funding for the desired level of readiness. IDA's research program is focused on identifying those portions of the defense budget that have the most direct and immediate impact on current readiness and those that have lesser or longer term effects on readiness. IDA also has developed methodologies that improve insights into those aspects of the defense program that lead to changes in readiness funding requirements.

As a first step in the research, IDA modified the historical budget database to permit readiness analyses to be based on a consistent representation of the use of defense resources over the past 20 years. Given this common baseline, IDA developed metrics that capture the combined effects of changes in equipment mixes and force composition on readiness funding requirements. These methods are now being employed in the review of the 1997 defense budget and are continually refined as better data become available.

Innovative Training Methods
The Defense Department has been a leader in the development of powerful new learning technologies, including simulation, networking, interactive multimedia, and video teletraining. Given constrained DoD resources, innovative approaches to training are necessary to reach and sustain needed levels of readiness. Policies and procedures must be devised to ensure that the levels of system effectiveness, and the personnel readiness that makes them possible, are achieved. This goal requires a comprehensive understanding of how to apply learning technologies to individual and collective military training in cost-effective ways.

IDA has been at the forefront of research on the costs, effectiveness, technical capabilities, and technical requirements of applying learning technologies to military training. Developing policies and procedures that encourage the successful use of new learning technologies has been a cornerstone of this ongoing research effort. This work supports defense training for residential ("schoolhouse") settings, for learning at physically distributed locations — especially those of the Reserve Components — and for just-in-time and just-enough training applications at job sites.

IDA has worked with industry and defense trainers to develop technical standards that increase portability, interoperability, and reuse of instructional materials across different hardware platforms and different instructional settings. And IDA continues to assess new learning technologies to recommend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promising applications and investments in their development and implementation.

Reserve Component Training and Readiness
IDA analyzed the personnel readiness requirements of the Reserve Components and the costs and effectiveness of available learning technologies to meet these requirements. This review showed that substantial readiness improvements are possible through use of these technologies, but that realistic plans and programs to employ them must be based on a training strategy that considers the total force and its infrastructure requirements. Development of a comprehensive strategy to invigorate training for military personnel and DoD civilians through applications of learning technologies is now under way. As the resources allocated to defense training decrease, these systems will be increasingly used to develop and sustain a ready force.

Environmental Planning and Technologies

Resources for Environmental Stewardship
The Department of Defense faces costly responsibilities for cleaning up environmental contamination generated over the years. IDA is providing analytical support for the development of a comprehensive DoD environmental program that includes alternative approaches to prioritizing competing Service demands for resources. Environmental resources are used to support cleanup, compliance, conservation, and pollution prevention activities, among others. This work requires analyses of all appropriate factors affecting investment decision making.

Approaches to cost analyses and cost containment are an integral part of these analyses. IDA provided a structured approach for collecting and assessing Service environmental needs and is now constructing a set of models to permit tradeoffs at various budget levels. As an example, IDA is using a high-level approach to decision making under uncertainty to facilitate rational but broader range budget and program analyses that will incorporate cost containment and policy variables.

This work has helped DoD develop and implement a new approach to planning, budgeting and accounting for those activities that are necessary to achieve the environmental goals of the Department.

Pollution Prevention
Congress and the Executive Branch have mandated that DoD achieve specific energy-saving goals, identify advanced energy-efficient technologies that are not yet commercially feasible, and provide incentives to encourage markets for environmentally preferable goods and services.

In response, DoD asked IDA to assess the maturity and potential efficacy of emerging energy-efficient technologies of interest to DoD and the Environmental Protection Agency. As part of this assessment, we evaluated how widely the technologies could be used and their cost benefits to DoD. We also identified barriers in the procurement system to acquisition of energy-efficient technologies, and recommended how DoD might modify its procurement mechanisms to obtain these technologies.

Leveraging the Environmental Programs of Other Departments
Although contamination has been individually recorded at thousands of DoD and Department of Energy sites, little work had been done to identify the major types of contamination across the entirety of the Defense and Energy complexes. An important aim of such an evaluation is to allow greater coordination and cooperation between the two Departments' technology programs.

Analyses to date have revealed three areas in which both Departments could benefit from technology partnerships in contamination cleanup: inorganics in ground water; volatile organics in ground water; and inorganics in soil. This effort suggested that DoD would be well-suited to assume a technology lead for fuels in ground water and in soil; and that the Department of Energy should lead in radionuclides in ground water and soil, and in volatile organic compounds in soil.

Force and Strategy Assessments

IDA conducts assessments relating systems, operational performance, force structure, and national security strategy. Studies examine past and present conflicts — such as those in the Middle East, in Grenada, in the Falklands, and in Bosnia — as well as joint exercises and peacetime operations. Our goal is to derive lessons learned and to assess the implications for defense plans and programs. IDA also examines broad national security strategy issues such as proliferation, use and control of weapons of mass destruction, regional security and arms control.

In addition to looking back at the air operations, IDA is assessing the performance of U.S. forces participating in the ongoing IFOR mission. We are focusing both on the deployment of units from Europe to Bosnia and on their subsequent in-theater employment in peacekeeping missions. IDA also is examining several new systems being used in Bosnia, such as the Joint Surveillance and Target Attack Radar System (JSTARS), to see how well they perform under real operational conditions.

Finally, IDA is assisting U.S. efforts to establish a stable military balance in Bosnia for the long term. To help prevent the war from restarting when the IFOR leaves, the Dayton agreement contains arms control provisions that would lead to more balanced military forces between the Bosnian Serbs and the Bosnian Muslim/Croat Federation. In addition, the United States is leading an international effort to equip and train Federation forces to correct their most serious military deficiencies. An IDA assessment of Federation military needs formed a principal input to U.S. planning for the equip and train program. The assessment included extensive visits with Federation military leaders, units, and facilities conducted during a two-week trip to Bosnia in late 1995.

Balancing Overseas Presence and Force Projection
The defense strategy of the United States calls for a mix of military power projection capability and day-to-day overseas presence of forward-deployed military forces. IDA is developing unique tools for evaluating the contribution of overseas presence to U.S. national security. In one effort, the contribution of U.S. military presence is compared with other possible U.S. actions — such as diplomacy, economic incentives and power projection — to determine their relative abilities to promote U.S. influence, reassure friends, bolster deterrence, and provide initial crisis response capabilities. As part of this analysis, we identified several efficiencies that could enable DoD to maintain roughly constant levels of overseas presence, at reduced costs.

Improving Joint Force Deployments
The United States Atlantic Command is responsible for providing U.S.-based forces to the five Commands with geographic areas of responsibility. This year, USACOM asked IDA to examine how to improve the planning and execution of joint operations. This study addresses four key areas: doctrine, organization, planning tools, and reporting systems.

Results of this effort point to several areas for improvement. First, no overarching document describes the joint reception, staging, and onward movement integration processes. This means that little consistency exists in planning and execution. Further, the connectivity between geographic commands and functional commands, e.g., those providing strategic lift, is not well defined. This results in an *ad hoc* approach to joint reception, staging, and onward movement in crises.

Second, many automated planning systems exist, but few are concerned with critical issues of theater deployment or sustainment. And finally, of the various reporting systems deployed or developed, most do not interface with each other.

Improving Assessments of Joint Force Readiness
Joint operations have become the norm. As such, the assessment of joint operations and joint readiness has received considerable emphasis in the last few years. Two independent assessment processes are now ongoing within the Joint Staff: the Joint Monthly Readiness Review, which is based largely on resource data and subjective judgments, and the Joint Training System, through which Joint Mission Essential Tasks are identified and evaluated.

Currently, it is difficult for planners to integrate these two assessments. IDA is assessing several ways in which both structures can be utilized cohesively in joint readiness reviews. Our findings indicate that the monthly review can profitably use the training system structure to improve the quality and completeness of the joint readiness assessments. However, the training system structure is still under development, and its data collection systems are still in their infancy. Consequently, much work remains before performance data from joint training, exercises, and operations will have the needed impact on readiness assessments.

Intratheater Lift for Logistics Support
IDA participated in a study established by the Joint Staff to assess the intratheater lift required

to move units and sustainment from ports of entry or prepositioned locations in a theater to locations where they are needed for combat. We analyzed the input data used during the Bottom-Up Review and other, related planning efforts, and made recommendations for improving and updating the data. Analyses of the model output identified shortfalls, associated risks, and possible remedial solutions. Also, IDA incorporated evolving Service concepts for logistical support to deploying forces into the intratheater transportation modeling effort.

Humanitarian Operations

Humanitarian relief operations have become a major focus of both planning and operations of U.S. forces in Europe. Among the many challenges this poses for the United States European Command is the need to work closely with international organizations such as the United Nations Department of Humanitarian Affairs, the International Atomic Energy Agency, the High Commissioner for Refugees, the International Federation of the Red Cross/ Red Crescent, and a host of non-governmental organizations and private voluntary organizations.

Typically, USEUCOM establishes a Joint Task Force to respond to an emergency and to coordinate with the nations and organizations involved. The task force often must develop experience, doctrine, and operating procedures during the crisis. To better prepare forces for humanitarian relief operations, USEUCOM is conducting exercises to train theater forces and is developing operational plans and concepts.

IDA is supporting USEUCOM in a series of scheduled humanitarian relief exercises. The first such exercise, scheduled for early 1996, is based on a scenario in which a nuclear power plant in Lithuania fails and the U.S. government directs USEUCOM to provide humanitarian assistance, in conjunction with many other responding nations and disaster relief organizations. Our staff developed the exercise concept, determined potential participants from the United States as well as other nations and international and non-governmental organizations, and provided reference documents and background material. We will also participate in the development and conduct of the exercise itself, and prepare an after-action report.

Defending Against Biological Agents

The potential for catastrophic personnel losses from biological weapon attacks on large, deployed combat forces is of urgent concern to U.S. policy makers and military planners. After Desert Storm, the United States identified major shortfalls and deficiencies in our ability to detect and identify biological warfare agents. As a result of these deficiencies and the continued proliferation of biological weapons programs worldwide, DoD initiated a wide-ranging bio-defense program combining the detection, protection, and medical measures of biological defense that together can protect U.S. forces from the effects of biological weapon attacks.

Drawing on our expertise in chemical and biological warfare, our technical knowledge of weapon systems, and our experience in the modeling and simulation of joint forces, IDA is helping bring focus to the various components of DoD's bio-defense program. By providing strategic, operational and tactical level insights about the military utility of the bio-detection systems the Services are now developing, we are offering recommendations on the most promising technologies. Our analysis has covered systems and technologies of point detectors, as well as short- and long-range standoff detectors; the development of operational concepts for detector employment in support of military forces; and tradeoffs between the detection, protection, and medical measures of bio-defense.

Our work in this area has led to changes in the Operational Requirements Document for the currently designed point detector — the Biological Integrated Detector System — to make it more sensitive. It also has highlighted the value of long-range standoff detection; increased awareness of the need for integrating bio-defense measures; and established IDA's operational assessment methods as the community standard.

We are now involved in an effort to improve DoD's understanding of the casualty potential of biological warfare and of ways in which current biological defense programs contribute to casualty reduction.

High Performance Computing and Communications

IDA is a key component of the National Security Agency's research endeavor. For almost 40 years, we have provided cutting-edge research in disciplines fundamental to the NSA mission, particularly mathematics and computer science. Reflecting changes in NSA needs and the state of computing more generally, our research program has evolved into two separate, but interrelated, sets of activities.

Communications Research

The Centers for Communications Research conduct mathematical research supporting the twin tasks facing the cryptologists of the NSA: cryptography and cryptanalysis. Mathematics remains the fundamental science used to create and analyze the complex algorithms used to encipher vulnerable communications. As the modes and means of modern communications became more complex, the NSA asked that the Centers expand their research into other areas, including speech and signals analysis.

To complement IDA's own research program, each Center hosts a special study program every summer ("SCAMP") for an eight- to ten-week period in order to attack some of the NSA's hardest and most important problems. For these programs, about 20 academic mathematicians of all ages and specialties are brought in to work closely with the regular CCR staff and also with visiting NSA mathematicians. In the summer of 1995, the two CCR SCAMPs focused on problems with underlying themes related to optimization in the broadest sense. One common thread to these topics, and indeed to much of CCR's work, is the interplay between discrete and continuous methods.

Computing Research

The purpose of the Center for Computing Sciences is to focus the skills and talents of computer scientists, engineers, and mathematicians on exploiting the potential of high-performance computing techniques, including parallel processing, to solve intelligence-related problems critical to national security.

"Computational Science and Engineering" is a good generic descriptive term for the research of CCS. Applications include various aspects of signal processing, optimization methods, and symbolic computation, as well as fundamental issues in machine architecture, computer arithmetic, and network and systems design.

Of necessity, specific details of the work of CCS are classified. However, general technology issues facing the entire HPCC community can be discussed. Indeed, initiating such discussions is an important part of the CCS mission.

CCS is active in HPCC areas such as devising algorithms, methods, and tools suitable for massively parallel architectures. There are several efforts in the design of programming models and languages and exploration of new architectural approaches based on advanced technologies. CCS is also addressing issues in distributed computing, including bandwidth, cost, and robustness.

Several examples of CCS work are sketched below. The first two are general purpose tools and the second two are specific applications.

AC — A Language for Parallel Machines
In principle, massively parallel machines have a very large memory space. However, the awkwardness of moving data between processors has prevented the use of the large memory as a single shared memory. The AC language, written at CCS, is a parallel version of C that enables message passing on both the Thinking Machines CM-5 and the Cray Research T3D. The message passing on the T3D is so fast that, for the first time, the machine can be used in a truly parallel fashion for NSA applications. AC is expected to influence the next generation of parallel software produced by Cray Research, now part of Silicon Graphics, Inc.

Message Passing Interface — A Framework for Parallel Programming
The Message Passing Interface (MPI) is an evolving standard for expression of message passing primitives. MPI has been adopted by nearly all major manufacturers of high-performance computers, including Cray Research. CCS staff have been involved in the community-wide development of MPI as well as in its application to specific NSA problems.

Parallel Groebner Basis Code — Symbolic Computing on Parallel Machines

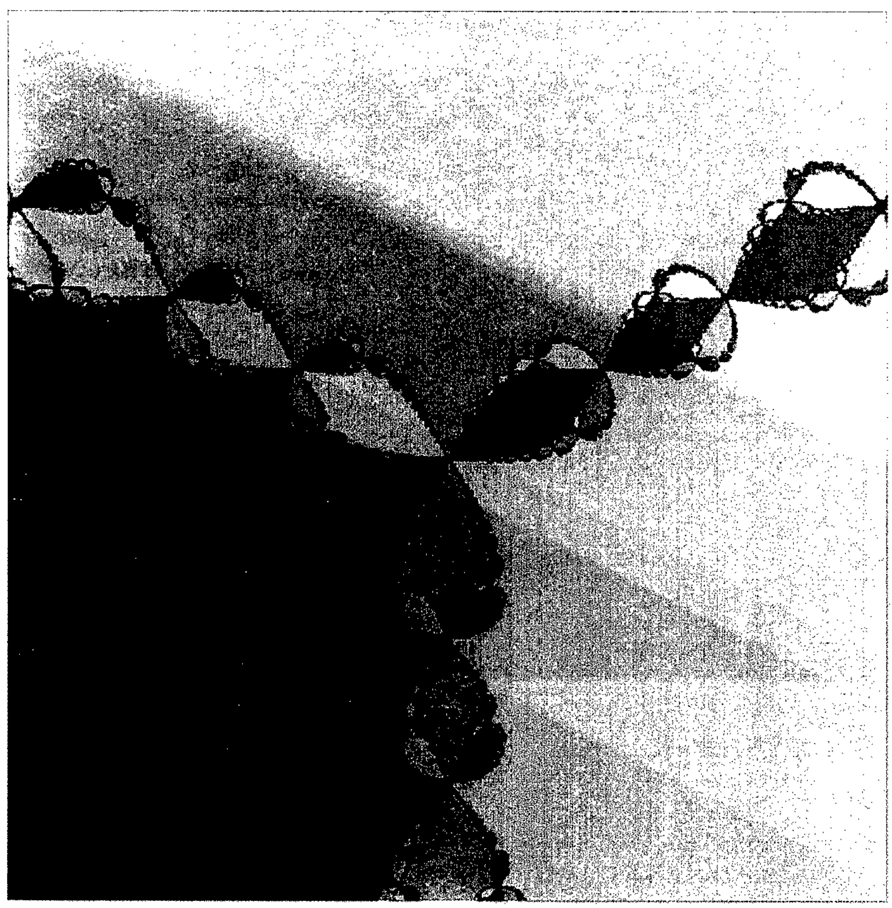
The Groebner basis method is a set of algorithms for reformulating very complex algebraic expressions as combinations of much simpler basis expressions. In a general sense, it is an elaboration of Gaussian elimination. However, because the calculation is symbolic and the expressions are complex, the computational power required is very much greater than for Gaussian elimination.

The newly developed parallel code, written in AC, allows users to access the full power of the T3D and is the first such program in the field of symbolic computing.

PRISM — A New Approach to Finding Eigenvalues

The PRISM software, developed by CCS in collaboration with Argonne National Laboratory, is an implementation of a radically new method for finding all eigenvalues of very large matrices. The techniques are well adapted to parallel architectures and run on several platforms, including Intel, IBM's SP-2, and Cray's T3D.

Domains of attraction for the Newton-Raphson Cube Root Iteration



IDA and its People

Trustees and Officers

The Board of Trustees provides basic policy guidance to the Corporation and its Officers. An Executive Committee is empowered to act for the Board between meetings. Additional committees include a Finance and Audit Committee and a Visiting Committee.

Corporate Officers

General Larry D. Welch, President and Chief Executive Officer

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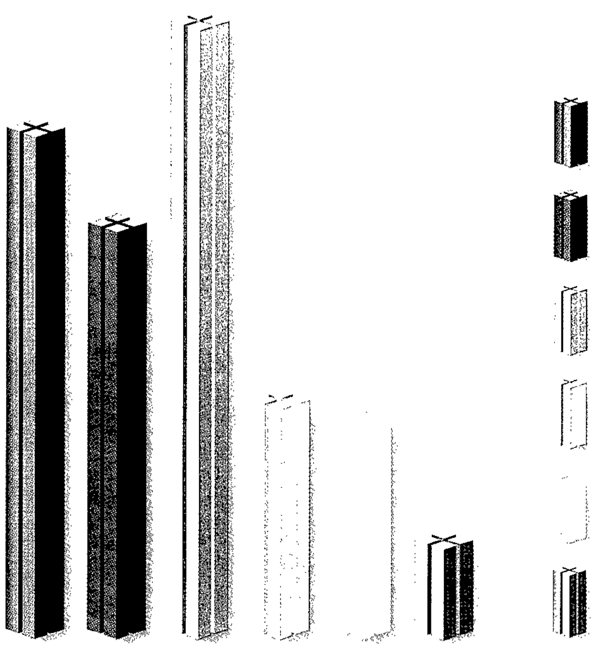
Staff

The Institute's research staff represents expertise in disciplines ranging from mathematics, engineering, and the physical and analytical sciences to international affairs, economics, and human factors. To augment this expertise, specialists from universities, industry, and other research organizations are called on to contribute their skills as consultants, members of technical panels and working groups, or as staff members on temporary assignment.

As of January 1996, the IDA staff numbered 786, of whom approximately one-half are research staff members. Among the research staff, 62.7 percent hold Doctoral degrees; an additional 29.3 percent hold Masters degrees.



Engineering 24.4 %

Physical Sciences 19.8%

Math, Statistics and Operations Research 29.7%

Computer Science 11.2%

Economics and Political Science 10.5%

Other 4.4%

Research Divisions

IDA is divided into nine research divisions and the Simulation Center.

Centers for Communications Research-Princeton and La Jolla
Dr. David M. Goldschmidt, Director, CCR-Princeton
Dr. Alfred W. Hales, Director, CCR-La Jolla

The Centers for Communications Research conduct fundamental research supporting the National Security Agency in cryptology, including the creation and analysis of complex encipherment algorithms, as well as speech and signal analyses.

Center for Computing Sciences
Dr. Francis Sullivan, Director

The Center for Computing Sciences conducts research supporting the National Security Agency in many disciplines of computational science and engineering, including computational algorithms and methods, computer architectures, robust operating systems, parallel processing, applications of computing to various aspects of mathematics and applications of mathematics to computational issues.

Computer and Software Engineering Division
Dr. Richard J. Ivanetich, Director

The Computer and Software Engineering Division conducts analyses and assesses the application of advanced computing systems and information technologies. The research program also addresses the development of advanced computational techniques and their operational application as prototype systems.

Cost Analysis and Research Division
Dr. Stephen J. Balut, Director

The Cost Analysis and Research Division collects, analyzes and estimates the full life-cycle costs of acquiring and operating forces, systems and components. The division also creates new or improved methodologies and computer-based models for cost estimation, frequently pushing the state of the art.

Operational Evaluation Division
Mr. Thomas P. Christie, Director

The Operational Evaluation Division supports the Office of the Secretary of Defense in the planning and evaluation of Service operational tests of major new weapon systems, and in the observation and evaluation of Live Fire Tests of the lethality and vulnerability of weapons and platforms. The division also supports the Joint Staff and Combatant Commands in analyzing military operations and in developing, integrating and improving the mission planning process.

Science and Technology Division
Dr. Lemmuel L. Hill, Director

The Science and Technology Division investigates and models scientific phenomena and conducts technical characterizations and evaluations of devices and systems, the media in which they operate, the targets they engage, and the missions they perform. The division also conducts technology assessments critical to research and development programs, acquisition decisions, and technology planning.

Strategy, Forces and Resources Division
Mr. Michael Leonard, Director

The Strategy, Forces and Resources Division performs integrated, interdisciplinary studies of defense planning and policy related to national security strategy, structure and capabilities of U.S. and foreign forces, and infrastructure supporting U.S. forces.

System Evaluation Division
Dr. David L. Randall, Director

The System Evaluation Division analyzes the potential performance, technological risks and costs of systems proposed or in development, typically in support of acquisition decisions. The division also recommends ways to maximize system cost-effectiveness and flexibility and to minimize system vulnerabilities.

Simulation Center
Mr. L. Neale Cosby, Manager

The Simulation Center supports the six Virginia-based IDA research divisions in developing and applying advanced distributed simulation to defense analyses. It also provides a DoD-wide forum for demonstrating new simulation technologies and for educating potential users in the capabilities of advanced distributed simulation. The Center is a Washington node for the Defense Simulation Internet, thereby connecting IDA with other simulation facilities across the country and overseas.

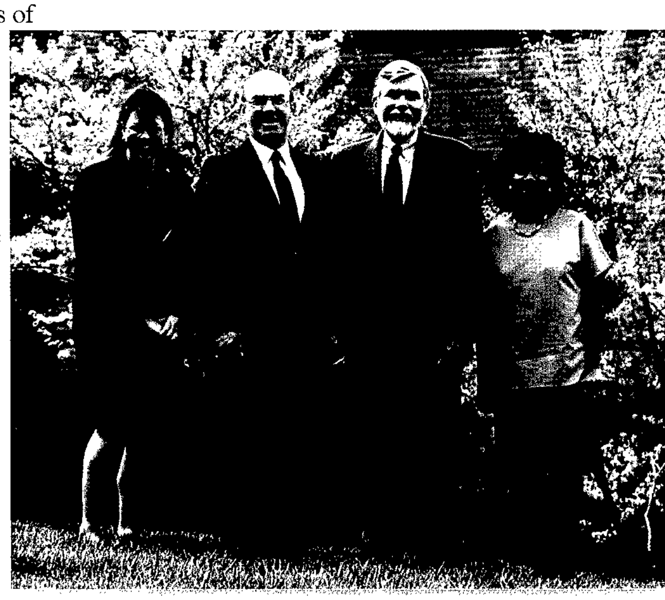
Awards for Excellence

IDA's ability to fulfill its mission depends on the intelligence, expertise and perseverance of its people. To underscore the Institute's dedication to excellence at all levels of the organization, IDA annually presents awards to staff members whose work, either over time or on particular projects, has been the most exceptional.

Dr. J. Richard Nelson of the Cost Analysis and Research Division was selected to receive the 1995 Andrew J. Goodpaster Award for Excellence in Research. Dr. Nelson has been one of the foremost contributors to the DoD's capability to forecast the costs of future weapon systems. His pioneering research and exceptional leadership have increased the visibility into and understanding of the costs of future weapon systems, thereby aiding the Department in making complex and controversial acquisition decisions. Dr. Nelson's exceptional performance and outstanding contributions have led to the development of a center of excellence at IDA in weapon system cost analysis that has significantly enhanced the Institute's value to DoD and its contributions to the national security. In addition to the many technical achievements he has realized during his distinguished 40-year career, Dr. Nelson has been a peerless educator and mentor to many current IDA researchers.

The W. Y. Smith Award for Excellence, designed to recognize outstanding contributions by non-research professionals, was awarded to *Thomas A. Smith* of IDA's Headquarters staff. As Research Task Administrator, Mr. Smith is responsible for tracking and processing over 300 IDA task orders/amendments each year. He is meticulous in his job, ensuring accuracy and timeliness of all task information. His outstanding organizational and interpersonal skills have earned him this recognition, as well as the respect of his colleagues throughout IDA.

The IDA President's Award for Excellence was established to recognize and reward support staff members who have made especially significant contributions to the Institute's success. This year, awards were presented to *Amy L. Cranford* of the Publications Services Office and *Dianna L. Gregory* of the Science and Technology Division. Each has contributed more than expected and has added significantly to IDA's efficiency and productivity. Both are respected and valued for their efforts.



1995 Awards for Excellence were presented to Dianna L. Gregory, Thomas A. Smith, Dr. J. Richard Nelson and Amy L. Cranford

Outreach

To maintain IDA as a center of excellence, we support a number of programs that help our staff stay current both in their disciplines and on changes in the external environment that should inform their work. We host a rich diversity of outside speakers who share their experiences and expertise with our staff. Technical seminars are held by the individual research divisions. We also accept a responsibility to help nurture future generations of defense analysts and citizens. The programs below represent the Institute's efforts to meet these multiple challenges.

IDA Speakers Program

Speakers this past year in IDA's seminar series included:

Colleen Preston, Deputy Under Secretary of Defense for Acquisition Reform
Daniel Roos, Director of the Center for Technology, Policy, and Industrial Development, Massachusetts Institute of Technology
June O'Neill, Director, Congressional Budget Office
Maj. Gen. Giora Romm, Defense and Armed Forces Attache, Embassy of Israel
Admiral William Owens, Vice Chairman, Joint Chiefs of Staff
Craig Fields, Chairman, Defense Science Board
Victor Reis, Assistant Secretary for Defense Programs, U.S. Department of Energy

DSSG members discussing urban terrain exercises with marines at Camp Lejuene, N.C.

Education Programs
The ties between IDA and the academic community have always been strong. Through these ties, IDA has had an infusion of new ideas, techniques, and access to the country's best and brightest scientists and engineers. Academia has benefited through exposure to real-world defense issues and the ability to contribute directly to our national security.

These ties have been created through innovative programs such as the Defense Science Study Group (DSSG) and the summer intern program, and have been maintained through special symposia for DSSG alumni and continuing programs in cost analysis with George Mason University. In 1995 IDA also started a Partnership in Education program with the Alexandria school system, aimed at improving the overall standards of education in our communities so that the next generation of leaders will possess the skills necessary to compete in an increasingly technical environment.

The Defense Science Study Group
The Defense Science Study Group program introduces leading young scientists and engineers to national security issues and the defense community. Under DARPA sponsorship, IDA organizes a two-year program of visits to military installations, laboratories and industrial facilities, and seminars by key defense officials. In 1995, the fourth DSSG class completed the program. Seventeen men and women, representing 14 universities and nine academic disciplines, focused on the preparation of think pieces on defense-related topics of special interest to them.

DSSG members visited the various intelligence agencies in the Washington area, as well as the Los Alamos National Laboratory, and the National Training Center at Fort Irwin, California, to observe exercises for armored forces. A high point of the year was a meeting with the Secretary of Defense, William Perry, during the June session. The final meeting was held at IDA in November. Members presented the results of their studies and heard from a number of representatives of various defense advisory boards concerning the many ways that academic researchers can remain involved in national security affairs. By year's end, the next DSSG class had been selected, with the first meeting scheduled for February 1996.

Summer Intern Program
During 1995, the IDA Summer Intern Program brought in 36 undergraduate and graduate students from numerous universities and

Summer interns meeting with IDA Vice President, Philip Major, for an introductory discussion of defense issues.

academies. Each was assigned to, and worked with, a research staff mentor. This year's group represented the disciplines of engineering, information systems, international affairs, computer science, math, physics, political science, economics, and business.

Cooperative Activities in Cost Analysis
IDA shares its expertise in cost research and analysis with the professional cost community in two ways: through conduct of a course in cost analysis, and through a DoD cost research symposium.

IDA research staff developed, and annually improve and present, a graduate level course in cost analysis in cooperation with George Mason University (GMU). Students include majors in operations research and the management sciences, and junior level to mid-level cost analysts working either for DoD or for the FFRDCs that support DoD. Starting in 1995, the course is being offered at IDA's Alexandria facility rather than on the campus of GMU. Through this course, the Institute shares up-to-date improvements on system cost estimating methods, force costing, and resource analysis techniques.

The IDA Cost Research Symposium is co-sponsored by the Cost Analysis Improvement Group in the Office of the Secretary of Defense. This symposium brings together the Directors of all DoD offices, military universities, and FFRDCs that conduct or sponsor cost research for an up-to-date report on research activities that are planned or in progress at each participating office. One product of this annual event is a catalog of ongoing cost research projects. This catalog facilitates the timely exchange of cost data and methods, and forms the basis for planning future cost research investments at DoD offices as well as at universities and FFRDCs that support DoD.

Community Volunteers
We at IDA provide opportunities for our employees to volunteer their time and talents to help motivate, enrich and develop America's young men and women. There exists a clear link between our outreach program and the Institute's primary mission of supporting national security decision making; we see this link as one of preparing our youth for the challenges they will face as leaders of the free world.

Explorer Post
Exploring is the Boy Scouts of America's senior program for high school students. It provides first-hand career exploration opportunities as well as outside, community and social activities. This is IDA's second year sponsoring a Computer Science Explorer Post. Over 30 IDA staff members have volunteered to help make this a rewarding program. The Explorer Post meets monthly for lectures and hands-on experiments involving computer science and other scientific disciplines represented at IDA. Programs have included computer security, programming, graphics, networking, simulation, a technical career night, and more. Some of the outside activities have included a canoe trip, biking and a tour of NASA.

Partnership in Education
An exciting partnership exists between IDA and the Alexandria public schools, one which matches the needs of the students and teachers with the interests and expertise of IDA's diverse staff. This "Partnership in Education" program is currently in its second year; and over 60 of our staff — both professional and support — have volunteered their time and talent to enrich the education of our youth. Partnership in Education has provided tutors, guest lecturers, mentors for gifted and troubled youths, and professional development for the teachers.

Financial Report

Balance Sheets

September 29, 1995 and September 30, 1994

	1995	1994
Assets		
Current assets:		
Cash and cash equivalents	$ 11,967,386	$ 8,808,039
Contract receivables	15,523,496	14,156,316
Prepaid expenses	330,739	444,375
Total current assets	27,821,621	23,408,730
Prepaid bond interest, less current portion	143,459	157,482
Prepaid ground rent, less current portion	1,090,000	1,111,800
Property, plant and equipment - net	24,585,747	25,164,353
Other assets	115,546	45,346
Total assets	$53,756,373	$49,887,711
Liabilities		
Current liabilities:		
Current portion of long-term debt	$ 774,155	$ 774,155
Accounts payable and accrued expenses	6,453,577	4,884,400
Accrued annual leave	3,646,265	3,557,356
Accrued pension costs	211,431	100,000
Accrued post-retirement benefit costs	623,000	545,000
Total current liabilities	11,708,428	9,860,911
Long-term debt, less current portion	7,175,632	7,950,565
Total Liabilities	18,884,060	17,811,476
Corporate Equity		
Corporate Equity	34,872,313	32,076,235
Total liabilities and corporate equity	$53,756,753	$49,887,711

Statements of Revenue and Expenses and Change in Corporate Equity

for the years ended September 29, 1995 and September 23, 1994

	1995	1994
Revenue:		
Contract revenue, including fixed fees of $5,489,401 and $5,031,347, respectively	$ 110,630,281	$ 107,264,165
Program expenses:		
Charged to U.S. Government contracts:		
Direct salaries	50,335,666	49,887,728
Other direct costs	31,469,380	29,272,033
Indirect costs	24,335,834	22,949,262
	106,140,880	102,109,023
Charged to Institute projects:		
Direct salaries	297,810	1,117,430
Other direct costs	1,056,394	1,254,736
Indirect costs	759,159	1,563,161
	2,113,363	3,935,327
Total program expenses	108,254,243	106,044,350
	2,376,038	1,219,815
Interest income	420,040	270,173
Bond arbitrage rebate	-	(22,200)
	420,040	247,973
Excess of revenue over program expenses before cumulative effect of change in accounting principle	2,796,078	1,467,788
Cumulative effect of change in accounting principle	-	(489,000)
Excess of revenue over program expenses	2,796,078	978,788
Corporate equity:		
Beginning of year	32,076,235	31,097,447
End of year	$ 34,872,313	$ 32,076,235

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- Director, Defense Research and Engineering
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Joint Staff and Commands

Defense Agencies

Defense Advanced Research Projects Agency
Ballistic Missile Defense Organization
Defense Information Systems Agency
Defense Nuclear Agency
National Security Agency

Other Federal Agencies

National Aeronautics and Space Administration
Department of Energy
Department of Transportation
United States Coast Guard