Chapter III

DEFENSE BASIC RESEARCH PROGRAM OVERVIEW

A. CHARACTER AND MANAGEMENT OF PROGRAM

1. Character of Defense Basic Research

Basic research is concerned with the discovery and development of fundamental knowledge and understanding, generally without regard to a specific application. Specific applications are generally addressed by applied research, although it is difficult to state hard and fast rules for delineating the boundary between basic research and applied research. Rather, basic research should enable many potential applications and uses. Likewise, *defense* basic research is concerned with the discovery and development of fundamental knowledge and understanding, focusing on future technology applications benefiting *national defense*. Although end uses may differ, the character of *defense* basic research is mostly indistinguishable from any other research in a similar scientific or engineering area. Where it is distinguishable is more by the *researcher* and his or her motivation than by the *research* as such; that is, the performer should always be aware of opportunities to benefit defense even when his or her research blends into similar research activities supported by other federal research programs. Such blending is in fact highly desirable as it increases the influx of fresh ideas for defense applications.

2. Management of Defense Basic Research

Defense research oversight is provided mainly by or through the Army Director of Research and Laboratory Management (SAAL–TR), the Army Research Office (ARO), the Office of Naval Research (ONR), the Air Force Office of Scientific Research (AFOSR), the Defense Advanced Research Projects Agency (DARPA), and the Defense Threat Reduction Agency (DTRA) Joint Science and Technology Office for Chemical and Biological Defense (JSTO–CBD). Oversight of the DoD Basic Research Program is the responsibility of the Director for Basic Sciences in the Office of the Deputy Under Secretary of Defense for Laboratories and Basic Sciences (DUSD(LABS), located in the Office of the Director of Defense Research and Engineering (DDR&E).

3. Strategic Research Areas

Strategic Research Areas (SRAs), described in more detail in Chapter VI, are areas of particular interest, emphasis, and benefit to DoD. SRAs are not projects in themselves; rather, they take advantage of ongoing basic research projects that might be nearing fruition (i.e., application) if combined with other research projects. SRAs identify common objectives that these research projects could pursue simultaneously to increase the opportunities for earlier transitions.

4. International Strategy

A key element of the *Basic Research Plan* is increased international awareness and interfaces. Therefore, it is critical that DoD maintain an expert knowledge of basic research activities and capabilities throughout the world. Intellectual capacity is not unique to the United States. An international element of the DoD *Basic Research Plan* can help achieve program objectives. The goal is to seek out research in foreign government laboratories and academic institutions where

world-class research in the 12 Basic Research Areas and the SRAs is performed. There are many ways to accomplish this goal, from review of research publications, to attendance at symposia, to joint research projects.

DDR&E supports interaction with all allies on the Multidisciplinary University Research Initiative and other research topics. DoD has begun a dialog with The Technical Cooperation Program (TTCP) member countries to encourage them to fund research in MURI topic areas so that a mutual exchange might occur. Another goal is to establish Master Information Exchange Agreements (MIEAs) with a number of our allies and friendly foreign countries. Under annexes to these arrangements, formal exchanges of research data can occur.

The Engineer and Scientist Exchange Program (ESEP) presents another excellent opportunity for mutual understanding of research capabilities. ESEP participation by DoD personnel and facilities is highly encouraged. DoD researchers should take maximum advantage of the international field offices operated by the Army, Navy, and Air Force. These offices report on international research capabilities and serve as centers of expertise in international science. They also fund programs aimed at bringing DoD and foreign researchers together in discussions aimed at apprising DoD of foreign research advances.

B. COMPOSITION OF PROGRAM

The Basic Research Program supports a wide range of activities spanning many scientific and engineering disciplines to provide a strong technical foundation to meet the diverse needs of the DoD services, agencies, and organizations. The Basic Research Program is primarily composed of two main elements: Defense Research Sciences and the University Research Initiative.

1. Defense Research Sciences

The Defense Research Sciences programs conducted by the Army, Navy, Air Force, DARPA, and the Office of the Secretary of Defense make up the largest component and the core of the DoD Basic Research Program. In FY04, the Defense Research Sciences programs totaled $0.882 billion (63 percent) of the total basic research funding of $1.403 billion. The Defense Research Sciences programs represent the largest source of DoD funding of university research, with the majority of the research being conducted by single investigators.

The core research disciplines are described in Chapter V, Basic Research Areas. The disciplines are coordinated by tri-service committees and the Scientific Planning Groups (Appendix A), with DARPA participation where appropriate.

2. University Research Initiative

The University Research Initiative (URI) is a collection of specialized research programs performed by academic research institutions. The URI program activities seek to improve the quality of defense research carried out by universities and support the education of engineers and scientists in disciplines critical to national defense needs. The URI program is administered by the services (ARO, ONR, AFOSR) and DARPA with oversight by the DDR&E Office of Basic Sciences. In FY04, the total URI funding level was $283 million, or 20 percent of the total DoD basic research budget.

A major component of the URI program, the Multidisciplinary University Research Initiative (MURI) program, supports strong interdisciplinary/multidisciplinary programs that are carried out by multidisciplinary academic teams, often involving more than one university,

working on research projects of strategic interest to DoD. The MURI program is described in detail in Chapter VII. Another important component of URI, the National Defense Science and Engineering Graduate Fellowship Program, is described below as well as later in Section C of this chapter.

a. Defense University Research Instrumentation Program

Research instrumentation is an essential part of the research infrastructure that underpins universities' long-term capabilities to continue to perform cutting-edge defense research. The Defense University Research Instrumentation Program (DURIP) helps to sustain that research infrastructure by supporting university researchers' purchases of major items of equipment costing $50,000 or more—items that rarely can be acquired within budgeted amounts of single-investigator awards. The DURIP's investment in major instruments complements the investments of military department and defense agency programs in more modest equipment items. In FY04, DURIP provided $26.9 million for major research equipment purchases in support of DoD's S&T investment of $1.2 billion in basic, applied, and advanced university research.

b. National Defense Science and Engineering Graduate Fellowship Program

The National Defense Science and Engineering Graduate (NDSEG) Fellowship Program is sponsored by AFOSR, ARO, and ONR. DoD is committed to increasing the number and quality of our nation's scientists and engineers. The actual number of awards varies from year to year, depending upon the available funding. Almost 300 fellowships were awarded in 2003. The NDSEG fellows do not incur any military or other service obligations.

NDSEG fellowships are highly competitive and will be awarded for full-time study and research leading to doctoral degrees in mathematics, physics, biology, ocean, and engineering sciences. Preference is given to applicants who indicate an intention to pursue a doctoral degree in, or closely related to, one of the following specialties: aeronautical and astronautical engineering; biosciences (excludes toxicology); chemical engineering; civil engineering; chemistry; cognitive, neural, and behavioral sciences; computer sciences; electrical engineering; geosciences (includes terrain, water, and air); material science and engineering; mathematics; mechanical engineering; naval architecture and ocean engineering; oceanography (includes ocean acoustics); and physics (includes optics).

The NDSEG Fellowship Program is open only to applicants who are citizens or nationals of the United States. Persons who hold permanent resident status are not eligible to apply. NDSEG fellowships are intended for students at or near the beginning of their graduate study in science or engineering. Applications are encouraged from women, persons with disabilities, and minorities, including members of ethnic minority groups such as Native American, African American, Hispanic, Native Alaskan (Eskimo and Aleut), or Pacific Islander (Polynesian or Micronesian).

3. Other Programs

a. In-House Laboratory Independent Research

The In-House Laboratory Independent Research programs allow defense laboratories to conduct quality basic research in the support of laboratory missions and to provide a research environment conducive to the recruitment and retention of outstanding engineers and scientists. Capitalizing on the availability of specialized research facilities and capabilities, the in-house

research program typically involves militarily relevant research that would not or could not be accomplished elsewhere. The in-house program totaled approximately $41 million in FY04, or about 3 percent of the total basic research funding.

b. Historically Black Colleges and Universities/Minority Institutions

The DoD Infrastructure Support Program for Historically Black Colleges and Universities/Minority Institutions (HBCU/MI) program, separately budgeted as part of DoD's applied research (6.2) element, is administered by the Office of Basic Sciences and executed by ARO and AFOSR. The HBCU/MI program provided approximately $20 million in FY04 to fund individual researchers, research consortia, instrumentation purchases, and the materials world modules program at eligible institutions.

The HBCU/MI program provides infrastructure support in fields of science and engineering that are important to national defense. Annual solicitations encourage participation of small minority schools as well as research institutions. Competitively awarded grants provide for research, collaborative research, education assistance, instrumentation, and technical assistance. Minority institutions, as defined by the Department of Education, are eligible to compete in five funding areas:

- *Research awards* contribute to the scientific knowledge base in areas important to DoD. Collaborative research allows university professors and students to work directly with military laboratories or other universities as well as with industry or small business partners.
- *Education grants* strengthen academic programs in science, mathematics, and engineering by providing equipment, scholarships, and work/study opportunities designed to attract students and encourage them to pursue degrees and careers in these areas.
- *DoD centers for science, mathematics and engineering* provide support to academic programs in research and education. DoD operates two research centers—(1) the DoD Center for Nano-scale Photonic Emitters and Sensors for Military, Medical, and Commercial Applications and (2) the Applied Mathematics Research Center—and two education centers—(1) the Urban Center for Student Successes in Science, Technology, Engineering, and Mathematics and (2) the Center for Assorted Learning Channels for Science, Mathematics, and Engineering Students.
- *Equipment grants* help institutions improve their capacity to perform research of interest to DoD and to train students in scientific disciplines. This program provides for the basic laboratory equipment as well as highly sophisticated research instruments.
- *Technical assistance grants* provide for programs designed to enhance the ability of minority institutions in areas such as proposal writing and administration of grants and contracts.

c. Government–Industry Cooperative University Research

The Government–Industry Cooperative University Research (GICUR) program combines industry know-how and funding with DoD interests and funding to support university research projects of mutual interest to industry and government. In FY04 this program, administered through DARPA, provided DoD funds of $6.1 million to support four university-based microelectronics research centers. The research is jointly funded by the U.S. semiconductor industry,

the semiconductor equipment industry, and DoD. Thus, the leverage is approximately 2:1 for each dollar from the government. Approximately $1.6 million was provided by DoD and industry to support Undergraduate Research Assistantships in FY03. The GICUR Program was transferred from OSD to DARPA in FY03 and continues as the Focus Research Center Program.

d. Defense Experimental Program To Stimulate Competitive Research

The Experimental Program To Stimulate Competitive Research (EPSCoR) was originated by the National Science Foundation (NSF) in 1979 and continues to provide a sheltered competition for university research grants in states that historically have received the least federal research funding. The intent for EPSCoR is to assist the state institutions to become more successful at receiving competitively awarded federal research funds by building the state-wide institutional infrastructure. DoD became involved in EPSCoR when Congress directed DoD to conduct a similar program and appropriated funds for that effort in FY91. The Defense Experimental Program To Stimulate Competitive Research (DEPSCoR) shares the basic goal of EPSCoR and uses the NSF list of EPSCoR states as the starting point for determining DEPSCoR eligibility. The NSF EPSCoR states in FY05 are listed below:

Alabama	Louisiana	New Mexico	Tennessee
Alaska	Maine	North Dakota	U.S. Virgin Islands
Arkansas	Mississippi	Oklahoma	Vermont
Hawaii	Montana	Puerto Rico	West Virginia
Idaho	Nebraska	Rhode Island	Wyoming
Kansas	Nevada	South Carolina	
Kentucky	New Hampshire	South Dakota	

Not all EPSCoR states are eligible for the DEPSCoR competition in any given year. The eligibility of the EPSCoR states is examined each year in accordance with guidance provided within the authorizing language (Public Law 103-337, as amended).

Each EPSCoR state has an EPSCoR state committee to coordinate the in-state activities. These committees are the focal points for solicitation and submission of the state DEPSCoR proposals. It is the responsibility of the state committees to identify and leverage in-state research and development capabilities with federal EPSCoR and EPSCoR-like programs to improve university research capabilities and infrastructure throughout the state with the goal of becoming more successful in full and open federal research and development opportunities. Active EPSCoR and EPSCoR-like programs are conducted by DoD, the Department of Energy (DOE), the Environmental Protection Agency (EPA), and National Aeronautics and Space Administration (NASA), the National Institutes of Health (NIH), the National Science Foundation (NSF), and the U.S. Department of Agriculture (USDA).

DoD is the third largest funding agency in the federal EPSCoR programs following NIH and NSF. DoD has awarded more than $190 million in research grants to EPSCoR states from FY91 through FY04 and considers the program to be a successful one that brings quality research efforts to DoD while providing university research investigators with an opportunity to connect with the defense research agenda and managers.

e. Chemical, Biological, Radiological, and Nuclear Defense Program

This program element is the DoD core research program for chemical, biological, and radiological (CBR) defense (medical and nonmedical). The Basic Research Program aims to

improve the operational performance of present and future DoD components by expanding knowledge in relevant fields for CBR defense and homeland security, to enable a highly mobile force with enhanced performance by the individual soldier, sailor, airman, or marine. Specifically, the program promotes theoretical and experimental research in the chemical, biological, medical, and related sciences.

(1) Nonmedical CBRN Defense. Research efforts are being initiated in technologies directly related to CBR defense and homeland security. The work in this program element is consistent with the Joint Service Nuclear, Biological, and Chemical (NBC) Defense Research, Development, and Acquisition (RDA) Plan.

This project area funds basic research in chemistry, physics, mathematics, life sciences, and fundamental information in support of new and improved detection technologies for biological agents and toxins; new and improved detection technologies for chemical threat agents; advanced concepts in individual and collective protection; new concepts in decontamination; detection and personnel protection techniques for radiological and nuclear exposures; and information on the chemistry and toxicology of threat agents and related compounds. Research areas include biological detection, chemical detection, protection, decontamination, supporting science, and modeling and simulation.

(2) Homeland Security. This basic research project emphasizes a better understanding of the threats and risks posed by future bioterrorism activities against the United States. Recent terrorism incidents in the United States demand an increased emphasis on research to assess the threat potential of classic, emerging, and genetically engineered biological threats. Funding for this project supports a capability for biological terrorism threat assessment research in a center for biological counterterrorism research, named the National Bioforensic Analysis Center, in collaboration with the Department of Homeland Security.

The proposed area of focus in FY05 will include microbial threat assessment basic research, which conducts technology surveys and identifies knowledge gaps with respect to biological threat agents. It will initiate expanded study of basic and molecular biology of threat agents, with emphasis on identification of virulence factors, pathogenic mechanisms, and structural biology.

(3) Medical Biological Defense. This project funds basic research on the development of vaccines and therapeutic drugs to provide effective medical defense against validated biological threat agents, including bacteria, toxins, and viruses. This project also funds basic research employing biotechnology to rapidly identify, diagnose, prevent, and treat disease due to exposure to biological threat agents. Categories for this project include current S&T program areas in medical biological defense (diagnostic technologies, bacterial therapeutics, toxin therapeutics, viral therapeutics, bacterial vaccines, toxin vaccines, viral vaccines) and directed research efforts (anthrax studies and bug-to-drug identification and countermeasures programs). Research areas include diagnostic technologies, therapeutics, anthrax studies, and vaccines.

(4) Medical Chemical Defense. This project funds research that emphasizes understanding of the basic action mechanisms of nerve, blister (vesicating), blood, and respiratory chemical agents. Categories for this project include science and technology program areas (pretreatments, therapeutics, and diagnostics) and directed research efforts (low-level chemical warfare agent exposure and fourth-generation agents). Research areas include diagnostics, therapeutics, low-level chemical warfare agent exposure, and pretreatments.

f. High-Energy Laser Program

The High-Energy Laser (HEL) basic research program, funded at $12 million in FY04, provides fundamental scientific knowledge to support future DoD HEL systems. HEL weapon systems have many potential advantages, including speed-of-light time to target; high-precision, nearly unlimited magazine depth; low cost per kill; and reduced logistics requirements because of no need for stocks of munitions or warheads. As a result, HELs have the potential to perform a wide variety of military missions, including some that are impossible, or nearly so, for conventional weapons. These include interception of ballistic missiles in boost phase; defeat of high-speed, maneuvering antiship and antiaircraft missiles; and the ultra-precision negation of targets in urban environments with no collateral damage. Research conducted under this strategic research area develops the technology necessary to enable these and other HEL missions.

The HEL program is part of an overall DoD initiative in HEL science and technology being conducted by the HEL Joint Technology Office (JTO), located in Albuquerque, New Mexico. The goals of the HEL JTO-funded research are to provide the technology to make HEL systems more effective and also to make them lighter, smaller, cheaper, and more easily supportable on the battlefield. In general, efforts funded under this program element are chosen for their potential to have major impact on multiple HEL systems and on multiple service missions. As a result of this focus and of close coordination with the military departments and defense agencies, this program complements other DoD HEL programs that are directed at more specific service and agency needs.

A broad range of technology is addressed in key areas such as chemical lasers, solid-state lasers, beam control, optics, propagation, free-electron lasers, and advanced lasers. Research is conducted principally by universities, but also by government laboratories and industry. The program funds theoretical, computational, and experimental investigations as well as modeling and simulation. In many cases, these types of investigations are combined under a single effort, thereby creating synergistic effects between various scientific approaches, which greatly enhance the potential for making important breakthroughs in HEL-related technologies.

To stimulate creative basic research, the HEL JTO—in collaboration with the ODUSD(S&T) Basic Research Directorate, the service research offices (ARO, ONR, and AFOSR), and DARPA—developed the High-Energy Laser Multidisciplinary Research Initiative (MRI). The HEL MRI was modeled after the MURI program, which is discussed in detail in Chapter VII. In both cases, research is to be led by university teams. The HEL MRI differs from the MURI in that the topic areas are specific to HEL technology and, to foster technology transfer, the university lead is able to provide some funding to collaborators in industry or Federally Funded Research and Development Centers (FFRDCs).

Research topics for the HEL MRI were developed by ARO, ONR, AFOSR, and DARPA. After discussions among the topic developers, the JTO and its technology area working groups, together with the ODUSD(S&T) Basic Research Directorate, selected six topic areas, involving thrusts from the service research offices and DARPA, for inclusion in the first HEL MRI call for proposals. The six topics and their associated offices are shown in Table III–1.

The Broad Agency Announcement (BAA) for the HEL MRI was issued in June 2001. Over 50 letters of intent were received across the six topics; evaluations were conducted and awards were subsequently announced. These projects are nearing completion, and a continuation review for an additional 2 years will be conducted in October 2004. In conjunction with this process, the JTO (with ARO as the executing agent) will issue a BAA in FY05 for new efforts.

Table III–1. MRI Topics

Topic Number and Title	Lead Office
1. High-Average-Power, Diode-Pumped Solid-State Lasers	DARPA/ARO
2. Affordable High-Energy Laser Systems	AFOSR
3. Atmospheric Propagation and Compensation of High-Energy Lasers	AFOSR
4. High-Power, Lightweight Optics	AFOSR
5. High-Energy Closed-Cycle Chemical Lasers	AFOSR
6. High-Average-Power, Ultra-Short-Pulse, Free-Electron Lasers	ONR

The six topic areas shown in Table III–1 overlap the technology thrust areas in the overall prioritized investment strategy of the HEL JTO extremely well. The topics and institutions for the MRI are listed in Table III–2.

Table III–2. FY02 MRI Selections

Topic	Institution
Power Scaling With High Spectral and Spatial Coherence	Stanford University
High-Energy Laser Multidisciplinary Research	University of Arizona, MIT
Advanced High-Energy Closed-Cycle Iodine Chemical Lasers	University of Denver
Multidisciplinary Research for High-Energy Closed-Cycle Chemical Lasers	University of Illinois
Atmospheric Propagation of High-Energy Lasers: Modeling, Simulation, and Tracking	UCLA
Fabrication, Testing, Coating, and Alignment of Fast Segmental Optics	University of Arizona University of Minnesota
High-Average-Power, Ultra-Short-Pulse, Free-Electron Laser	University of Maryland
Research in Support of High-Average-Power, Free-Electron Laser	Stanford University

The MRI program is for three calendar years followed by an option for two additional years. It is important to note that, assuming good technical progress, these proposals represent a minimum of a 3-year commitment by the HEL JTO. Each program will be reviewed annually. DoD intends to translate the knowledge developed under this program into proof-of-concept solutions to broadly defined HEL-related military applications as part of further laboratory experiments and field testing.

g. Force Health Protection

The DoD Force Health Protection Research Program (FHPRP) builds on successes from a decade of research on Gulf War illnesses to protect the health of those in future military deployments. Results of ongoing research on Gulf War illnesses continue to be transitioned to appropriate branches within DoD, to the Department of Veterans Affairs, and to the Department of Health and Human Services.

The objectives of the FHPRP are to support force health protection concepts to maintain a fit and ready force, to prevent casualties, to assure warfighters of protection against materiel and operational hazards, to improve methods of diagnosing and treating illnesses that put the future

health of warfighters at risk, to enhance performance under difficult operational conditions, and to coordinate unique DoD research programs in stress-induced dysfunction, toxicology, and epidemiology with research efforts by other federal departments.

The FHPRP has been managed largely through competitive solicitations, with the majority of funded projects going to extramural academic institutions. All research, including intramural projects, receives scientific peer review independent of DoD. This includes peer review of the projects before award and site reviews of continuing program projects.

The largest intramural effort is support to the DoD Center for Deployment Health. This center manages the 22-year Millennium Cohort Study and coordinates research to develop the Recruit Assessment Program, among other longitudinal epidemiological investigations into improved health monitoring strategies for DoD. The concluding extramural grants include competitive peer-reviewed grants to Georgetown University; VA Medical Center, San Francisco; and University of Texas, Southwestern Medical Center.

Significant accomplishments include development and establishment of the DoD Birth Defects Registry for early identification of associations with occupational and deployment exposures; development of a diagnostic skin test for Leishmania infection; development and validation of a standardized neuropsychological screening tool that is proving useful for baselining and followup of deployed troops' mental functioning; development of an initial baseline health information and risk factor tool; and improved understanding of single and combined risks to health from pyridostigmine bromide, DEET (N,N-diethyl-meta-toluamide), permethrin, and other operationally useful chemicals.

Of particularly significance are findings from multiple studies that no single cause has been identified for development of the poorly defined multisymptom illnesses afflicting Gulf War veterans; however, reports indicate that (1) self-reported symptoms are more prevalent in veterans who deployed to the Persian Gulf, (2) derangements of the autonomic nervous system are noted in several studies, and (3) there are preliminary epidemiological findings of increased risk for development of motor neuron dysfunction. To date, however, the main difference in mortality of Gulf War veterans compared with the general population remains a higher mortality as a result of vehicular accidents; this is being investigated but is currently unexplained.

In FY04 the FHPRP became a part of the core Army biomedical program, managed by the U.S. Army Medical Research and Materiel Command, within the DoD basic research portfolio. The program continues to support research in the areas of neurobiology of stress and immune function, deployment toxicology, epidemiology, health behaviors intervention (including weight management), and deployment health assessment. Funding for the FHPRP in FY04 was $14 million, including congressional add-ons. For FY05 and beyond, funding is projected to be $10 million per year for the intramural program.

C. SCIENCE EDUCATION AND INFRASTRUCTURE SUPPORT

The DoD Basic Research Program also provides education and infrastructure support for the education and training of future talented scientists and engineers and for the improvement of research equipment and instrumentation. Students and modern equipment and facilities are essential ingredients for scientific research.

The Basic Research Program provides for the education and involvement of undergraduate, graduate, and postdoctoral students and young investigators through a variety of policies and programs designed to create a new generation of scientists and engineers who will perform

research of importance to DoD and the country in the future. Many individual research grants to universities, as well as multidisciplinary university research grants (such as the MURIs), often include financial support for undergraduate students, graduate students, and post-doctorates in addition to research support for university faculty. Education and training fellowships are provided to outstanding individual scientists and engineering undergraduate and graduate students as part of the URI program element.

DoD also sponsors the NDSEG Fellowship Program. This program provides fellowships to substantial numbers of graduate students majoring in science and engineering areas of interest to DoD.

Science, mathematics, and engineering (SME) are vital disciplines to our national defense. Therefore, a formal DoD Science, Mathematics, and Research for Transformation (SMART) Scholarship has been established to promote the education, recruitment, and retention of undergraduate and graduate students in defense-critical skills and disciplines. DoD will offer these scholarships to clearable U.S. citizens who have demonstrated ability and special aptitude for training in SME. SMART participants will receive hands-on experience in SME internships with DoD during the summers and will be required to enter into an employment obligation with DoD.

DoD is collaborating with NSF on its Research Experiences for Undergraduates Site Program, which funds sites to provide research experiences for undergraduates who may not otherwise have access to research opportunities. DoD has also started a partnership with the Semiconductor Research Corporation Education Alliance to create an industry-matched undergraduate research program in disciplines of interest to the semiconductor and other high-tech industries. DoD provided approximately $4.5 million to support the Undergraduate Research Program with NSF. Approximately $1.0 million was provided in FY04 to support the Undergraduate Research Assistantship program in microelectronics with the SRC Education Alliance, which provided an additional $0.6 million.

D. TRANSITIONS FROM BASIC RESEARCH TO APPLICATIONS

To be successful, DoD basic research results must eventually lead to providing technologically superior weapon systems and products at a more affordable cost. Basic research must transition to industry and defense laboratories to enable development and engineering programs that result in rational, beneficial, cost-effective, and timely weapon systems.

As highlighted in Chapter I, Section F, the ultimate payoff of basic research is in moving leading-edge technologies into the field. DoD has an excellent record of transitioning technology; however, increased emphasis should be placed on shortening the time for insertion into fielded systems. Insertion will require planning for earlier transitioning of mature research projects. Planning for earlier transitioning is one of the principal objectives of the MURI research grants to universities, the SRA teaming of the Office of Research (ARO, ONR and AFOSR) managers in selected strategic research areas, and the GICUR research requiring university–industry connections.

As part of the basic research review process, for example, AFOSR has documented the transition of basic research outcomes to industry, defense laboratories, and other DoD/governmental organizations. Of the 737 documented transitions for FY02–03, there were 452 from universities, 214 from the Air Force Research Laboratory, and 71 from industries supported by AFOSR 6.1 funds. Of the 737 transitions, 356 were to industry, 151 were to DoD or other

governmental agencies, and 188 were to Air Force laboratories. There were 42 that overlapped multiple organizations.

The success stories identified throughout Chapter VIII are excellent examples of basic research that has transitioned to more advanced research stages or has resulted in new technologies already being utilized in many of today's weapon systems as well as in many nondefense applications.