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**THE DEPARTMENT OF DEFENSE  
REPORT ON  
SCIENCE AND ENGINEERING EDUCATION  
ACTIVITIES OF THE DEPARTMENT  
OF DEFENSE**

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JUL 19 1990  
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**FOR THE COMMITTEES ON ARMED SERVICES  
UNITED STATES CONGRESS**

**MARCH 1990**

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March 1990

THE DEPARTMENT OF DEFENSE REPORT ON SCIENCE AND ENGINEERING  
EDUCATION ACTIVITIES OF THE DEPARTMENT OF DEFENSE FOR THE  
COMMITTEES OF ARMED SERVICES UNITED STATES CONGRESS

NO PERSONAL AUTHOR

OFFICE OF THE DEPUTY DIRECTOR, DEFENSE RESEARCH &  
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LABORATORY MANAGEMENT

*Approved for public release Original report  
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In response to Section 843 of the Public Law 101-189 the National Defense Authorization Act this report addresses the issues of the Department of Defense programs "to preserve and perpetuate an effective scientific and engineering workforce." Included for evaluation are Summer Internships, Award Program for Exceptional Pre-college teachers, Undergraduate Scholarship Programs, expansion of the Barry Goldwater scholarship, Excellence in Education program and other programs which encourage scientific and engineering careers.

Education  
Scientists  
Manpower

Graduates  
Grants  
Universities

Students  
Engineering  
Department of Defense.

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ON  
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OF THE DEPARTMENT OF DEFENSE  
FOR  
THE COMMITTEES ON ARMED SERVICES  
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MARCH 1990

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## INTRODUCTION

This report responds to Section 843 of Public Law 101-189, the National Defense Authorization Act for Fiscal Years 1990 and 1991, which requires the Secretary of Defense to submit a report on Science and Technology Education Programs in the DoD as follows:

(a) FINDINGS. - Congress makes the following findings:

(1) The possession and maintenance of technologically superior systems in the Department of Defense is a critical part of the national defense strategy of the United States.

(2) Defense programs use a significant portion of the entire science and technology workforce of the United States.

(3) The science and technology workforce of the United States has been declining in recent years and that decline threatens the supply of qualified engineers and scientists for the Department of Defense in the future.

(b) SENSE OF CONGRESS. - In light of the findings of subsection (a), it is the sense of Congress that the Secretary of Defense should take such actions as may be necessary and appropriate to promote and encourage, at precollege through post-doctoral levels, an increase in the number of citizens and nationals of the United States who pursue courses of study in science, engineering, and other technical disciplines.

(c) Report. - The Secretary of Defense shall submit to the Committees on Armed Services of the Senate and House of Representatives, by February 1, 1990, a report on current, expanded and proposed new programs of the Department of Defense and, as appropriate, proposed interagency programs to preserve and perpetuate an effective scientific and engineering workforce for the United States for the future. The Secretary, in coordination with the Director of the Office of Science and Technology Policy, shall include in the report an evaluation of the following concepts:

(1) Summer Internships at Department of Defense laboratories for precollege teachers of science, engineering, or other technical disciplines.

(2) An award program for exceptional precollege teachers in sciences, engineering or other technical disciplines.

(3) A scholarship program for undergraduates in scientific or technical education who plan to teach those disciplines at the precollege level.

(4) Expanding the Barry Goldwater Scholarship and Excellence in Education Program or any other such program that the Secretary and Director mutually agree would promote increases in scientific and engineering careers.

The report which follows is divided into four sections: Section I provides an overview; Section II describes existing DoD programs and examines the potential for expansion; Section III addresses program effectiveness, new programs and evaluates concepts requested by the Committees; and Section IV provides conclusions and recommendations. Appendix A provides a data base of programs, participation level and funding and Appendix B contains supplementary information collected independent of the survey responses.

**SECTION I: SCIENCE AND ENGINEERING EDUCATION IN THE DEPARTMENT OF DEFENSE - AN OVERVIEW**

As Congress stated in the findings, the Department of Defense relies heavily on a strategy of technological superiority to counter the numerical superiority of potential adversaries and is a major employer of scientists and engineers. The U.S. science and engineering work force totaled 4,626,500 in 1986 according to the last National Science Foundation survey (1). Fields included in this survey are physical scientists, mathematical scientists, computer specialists, environmental scientists, life scientists, psychologists, social scientists and engineers. The survey also indicated that 13 percent of that work force (600,000) was in defense related activity, (1). The Department of Defense directly employs approximately 127,000 civilian and military scientists and engineers (2) or 2.8 percent of the national pool. Of this number, approximately 100,000 are civilian employees of DoD of whom 25,000 are engaged in research and development in DoD laboratories and centers (2). The DoD, therefore, has a vital interest in the ability of our nation's colleges and universities to produce highly trained scientists and engineers.

A number of factors may impact DoD's future ability to recruit and retain qualified scientific and technical personnel. Chief among the concerns is changing demographics that will markedly affect the composition of the work force. This concern is most concisely addressed in the report, "Changing America: The New Face of Science and Engineering," prepared in 1988 by the interagency Task Force on Women, Minorities and the Handicapped in Science and Technology (3). The report notes in particular that by the year 2000, 85 percent of the increase in new entrants to the work force is projected to be women, minorities, handicapped persons and immigrants, groups which traditionally have tended to choose careers other than science and engineering.

A second cause for concern is the decline in the percentage of U. S. citizens pursuing science and engineering degrees and careers. The total number of scientists and engineers in the work force increased at a rate of approximately 7 percent per year between 1976 and 1986 (1), however much of this increase was composed of non-U.S. citizens who are ineligible for federal employment. Over the period 1974 to 1985, the number of B.Sc. degrees awarded in science and engineering increased by only 0.5 percent per year, the number of M.Sc. degrees increased by 1.1 percent per year, and the number of Ph.D.s actually decreased by 0.02 percent per year (4). While these figures appear rather low, the situation for citizens and nationals is even worse since the overall figures are obscured by the large number of foreign students in U.S. schools. For example, in 1986 75 percent of the graduate students receiving financial aid from university engineering departments were foreign students and 50 percent of Ph.D.s awarded were to foreign nationals. Most of these students,

because of commitments to return to their country of origin; lack of U.S. citizenship; or ineligibility for a security clearance, are not available to the Defense science and engineering work force.

Moreover, the total number of college freshmen pursuing degrees in science and engineering (S&E) has also been dropping over the past decade (although recently released figures from an American Association of Engineering Societies study show a 3 percent increase over the previous year for 1988, indicating a possible reversal of the trend for engineering). Even more distressing is the poor performance exhibited by U.S. students on standardized math and science tests at the precollege level when compared to their contemporaries in other industrialized countries.

The DoD is thus faced with, a) a flat to declining supply of U.S. citizens graduating from universities; b) an unfavorable demographic projection for the groups that have traditionally provided the largest numbers of scientists and engineers; c) a decrease in the quality of high school graduates; and d) an unfavorable pay structure to compete for the available people. The recruiting problem could become even more difficult if the present loss rate were exacerbated by a further deterioration in the civil service pay schedule relative to the private sector. This is a serious problem for a Department that relies heavily on advanced technology.

In our efforts to reverse the decline we are seeking to correct deficiencies in the compensation and benefit package for S&Es in civil service, to effect changes in training regulations to allow government employees to obtain either undergraduate or advanced degrees in science and engineering as part of a training program, to develop exploratory programs using the Department of Defense Dependents Schools (DODDS), and to develop a cost model to guide investment strategies in intervention programs.

While the DoD has a clear interest in and concern for maintaining an adequate supply of well-trained scientists and engineers, the courses of action selected to address this issue must be consistent with the mission and statutory authority of the DoD. The Department of Education and the National Science Foundation have a major mission and a clear mandate to develop and conduct programs in science and engineering education. The DoD mission is to provide for national security, and any education programs it conducts must be in direct support of that mission.

The DoD does make a major investment in education and training, spending over \$32 billion a year to train 350,000 recruits; maintain technical skills of 750,000 technicians; conduct flight training for pilots; and support a host of other training activities to maintain a keen edge of operational readiness. In the more traditional educational setting, DoD provides education



for grades K through 12 for 200,000 dependents in overseas locations (DODDS) and in U.S. locations where the local civilian schools cannot meet the needs of the dependent population (Section 6). The Service Academies will graduate about 3,300 officers in 1990 and have a total enrollment of about 14,000. ROTC programs have an enrollment of about 87,000 with 21,740 on scholarships. Over 750,000 enlistees are participating in the Montgomery GI Bill plan which provides subsidies to assist them in completing their college educations. While these activities are representative of DoD education and training activities for military personnel, they are not primarily concerned with science and engineering education, and will not be considered further with the exception of the ROTC programs which do have a large science and engineering component.

Science and Engineering education activities in DoD are primarily centered around two functions: conducting research in support of national defense, and recruiting and retaining civilian employees in science and engineering career fields. The authority to conduct these activities comes from several sources including:

1. Section 2358 of Title 10 United States Code authorizes the Secretary of Defense to conduct basic and applied research that relates to weapons systems and other military needs by contract or grant to educational institutions. These contracts and grants also provide the funds for research assistantships for graduate students.

2. Chapter 41 of Title 5 United States Code authorizes training for government employees and assigns the Office of Personnel Management the responsibility to issue the necessary regulations for all Federal agencies. The regulations permit education and training to maintain and improve skills of government employees but do not permit the acquisition of a degree as the sole objective.

3. Executive Orders 12320 and 12677 direct Federal Departments and Agencies to support initiatives that will provide quality education at and increase the participation of Historically Black Colleges and Universities and Minority Institutions (HBCU/MI) in Federal programs.

4. Section 2360 of Title 10 United States Code permits DoD research laboratories to contract with students or not-for-profit organizations for research services of the students on an intermittent basis.

5. Section 2191 of Title 10 United States Code establishes the National Defense Science and Engineering Graduate (NDSEG) Fellowship program.

6. Section 9111 of Public Law 101-165, Department of Defense Appropriations Act, 1990 directs the Secretary of Defense to "design a comprehensive strategy to involve civilian and military employees of the Department of Defense in Partnerships with elementary and secondary schools...." Such partnership programs enable DoD employees to serve as unpaid volunteers under the supervision of education professionals. This provides statutory authority for pre-college programs previously conducted under executive orders.

7. A few other specific programs have been authorized to address shortages in critical skill fields such as the Health Sciences University (100 medical students per year), the Defense Intelligence School (advanced training in fields related to intelligence), and the National Cryptologic School (for advanced training in cryptology and related fields).

8. DoD regulations also permit facilities and personnel to be used for community relations programs if the effort does not adversely impact the primary mission of the facility, thus permitting tours and mentor and tutoring programs.

Science and engineering education programs in the Department of Defense are thus conducted in support of the primary mission, providing for national defense. The fact that these programs are operated under diverse authorities and are intended to support diverse objectives of the Department (i.e. research, training, recruitment, etc.) means there is no centrally managed science and engineering education office, nor a centralized data base. Such segmentation and dispersal of management function serves the various communities well, and there is, nonetheless, good overall coordination. The Research program offices of the Services, Army Research Office (ARO); Office of Naval Research (ONR); and Air Force Office of Scientific Research (AFOSR), all administer similar research programs with the academic community but differ in the mix of science and engineering disciplines funded. The Service research programs are coordinated for the Secretary of Defense by the Office of Research and Laboratory Management. The DoD programs are also coordinated with other agencies such as National Science Foundation, Department of Energy, National Aeronautics and Space Administration, and National Institutes of Health to assure that stipends are comparable, policies are uniform, and common problems are recognized. The Personnel programs are coordinated by Office of Personnel Management for all Federal agencies in terms of the generic programs available, but each organization may emphasize different programs to fit its needs. Equal Employment Opportunity (EEO) guidelines are likewise established government-wide but the design of intervention programs to fit a local situation is left to the individual base or laboratory.

The tasking to survey programs for the purposes of this report was issued concurrently with the request to evaluate existing

programs and develop a plan for future expansion. The tasking letter was jointly signed by the Director of Defense Research and Engineering and the Assistant Secretary of Defense for Force Management and Personnel and was sent to the Military Departments and Defense Agencies. The information requested included a description of the program, program objectives, program history, performing organization, coordination, program evaluation and projection of future plans.

Responses to the tasking letter were received from the Defense agencies and the Departments listed in Table I. The responses were submitted in various levels of detail and compliance with the format requested. Information on programs administered by a central office tended to be fairly complete while information on programs operated at the local level were considerably less complete. Part of the difficulty lies in the fact that training programs that emphasize science and engineering are not normally distinguished from other training for management, finance, etc. Nonetheless, the information made available by the survey provides a fairly complete picture of the type of programs conducted and/or supported by the DoD and permits a reasonable assessment of the types of programs which are successful and merit continued support or expansion. However, the survey does not provide comprehensive details of the number of participants and the amount of funding across DoD for all of the programs.

TABLE I

COMPONENTS RESPONDING TO SURVEY

DEPARTMENT OF THE ARMY

Assistant Secretary (Personnel)  
Army Materiel Command  
Army Corps of Engineers  
Army Research Office

DEPARTMENT OF THE NAVY

Assistant Secretary (Civilian Personnel)  
NAVAIR  
NAVSEA  
NAVFAC  
NAVSPAWAR  
Office of Chief of Naval Research

DEPARTMENT OF THE AIR FORCE

Air Force Civilian Personnel Management Center  
Air Force Office of Scientific Research

DEFENSE AGENCIES

Defense Mapping Agency  
Defense Intelligence Agency  
Defense Nuclear Agency  
National Security Agency  
Strategic Defense Initiative Organization - No programs  
Defense Logistics Agency - No programs  
Defense Investigative Service - No programs  
Defense Contract Audit Agency - No programs

## SECTION II: DESCRIPTION OF EXISTING PROGRAMS

The Department of Defense supports a wide variety of programs which involve science and engineering education either directly, such as fellowship support for students or tuition payments for employee training, or indirectly, such as work experience in DoD laboratories or by research performed on DoD grants to universities. The programs include all levels of education from pre-college to post-doctoral with the largest level of support at the graduate level. Programs described include both training for Department civilian employees and broader efforts to increase the supply of scientists and engineers. Science and technology education activities in the military which include the Service academies, Service post-graduate schools, technical training schools, and education programs for Service personnel are substantial activities but are not addressed in this report which deals with civilian science and engineering education. Likewise recruiting activities which have no component of education are not considered in this report.

Program descriptions of 112 discrete programs were received from the survey. These responses were categorized by the education level addressed, pre-college, undergraduate, graduate, and post-doctoral (including faculty). The programs were then further characterized by the primary purpose of the program which included: stimulation of career interest in science and technology; improvement of the quality of teaching; provision of experience in a laboratory setting; targeting of under-represented groups, such as women and minorities; fellowship support for other than employees; training programs to improve the knowledge and skills of government employees; and the performance of military research, which on the one hand provides new knowledge and on the other provides training at the early stages of a career or at career field changes. A tabulation of programs with information on the reporting component, unit at which the program is implemented, date the program was initiated, number of participants in 1989, support in 1989 in thousands of dollars, number of female participants and number of minority participants (including minority females) is provided in Appendix A. Unless specifically stated to the contrary, U.S. citizenship is a requirement to participate in these programs. A narrative description of each type of program is provided in the following section in accordance with the following outline:

PRE-COLLEGE LEVEL EDUCATION PROGRAMS

- A. IMPROVE QUALITY OF SCIENCE EDUCATION
- B. STIMULATE CAREER INTEREST
- C. TARGETED PROGRAMS FOR WOMEN AND MINORITIES
- D. EXPERIENCE PROGRAMS

UNDERGRADUATE LEVEL EDUCATION PROGRAMS

- A. ROTC
- B. EXPERIENCE PROGRAMS
- C. TARGETED PROGRAMS
- D. EMPLOYEE TRAINING

GRADUATE LEVEL EDUCATION PROGRAMS

- A. FELLOWSHIPS
- B. EXPERIENCE PROGRAMS
- C. CONDUCT RESEARCH
- D. EMPLOYEE TRAINING

POST-DOCTORAL AND FACULTY LEVEL EDUCATION PROGRAMS

- A. CONDUCT RESEARCH
- B. TARGETED PROGRAMS

## PRE-COLLEGE LEVEL EDUCATION PROGRAMS

### A. PROGRAMS TO IMPROVE QUALITY OF SCIENCE EDUCATION:

The National Science Resources Center (NSRC) is a project jointly sponsored by the National Academy of Sciences and the Smithsonian Institution. The DoD has provided approximately one-third of the funding for a study to examine factors which could improve the quality of science teaching at the elementary school level. Activities of the NSRC during the first three years of a five-year program have been to identify school systems which provide exemplary science programs; collect science resource materials; disseminate information on science resource materials through a network established by NSRC; develop instructional materials for three critical science concepts; field test these materials; and conduct training workshops for elementary science teachers. The field testing was conducted at 21 elementary schools in 13 school systems including DoD Dependents Schools in the Philippines and several schools with large black or hispanic student populations. A workshop conducted in 1987 involved participants representing 13 school systems with a combined enrollment of over 500,000 students. Negotiations are currently in progress to make the materials available through a commercial vendor. The results of the study will be widely disseminated to the DODDS system. The major thrust of the program is to improve the quality of science teaching methods and to stimulate an interest in science at an earlier age. The DoD portion of the program was conducted under the authority of the Secretary of Defense to undertake studies on subjects of interest to the Department.

Another program which addresses quality of S&T education is the ARMY HIGH SCHOOL SCIENCE AND MATHEMATICS FACULTY program, administered by the Army Research Office, which provides six to ten weeks of experience in an Army laboratory for high school faculty members. The experience is intended to provide an appreciation for the professional challenges undertaken by scientists and engineers; an exposure to current state-of-the-art research topics; and hands-on experience with modern research instruments. The program is conducted at 30 Army laboratories at various locations around the country during the summer months. Pay of \$450 per week is provided. The program is considered to be successful and (barring major Army budget cuts) will continue at the current level.

### B. PROGRAMS TO STIMULATE INTEREST IN SCIENCE AND TECHNOLOGY CAREERS:

Programs in this category are intended to capture the interest of students at an earlier age through awareness of science

activities and to provide students with information on opportunities in science and technology careers. Many programs involve brief exposure of students to science activities through tours of DoD laboratories and centers, lectures by DoD scientists and engineers in the school, or use of DoD scientists as judges in science fairs, etc. Expenditures of funds for these activities are small and mostly consist of the duty hours expended by individual employees in these activities. Because of the diffuse nature of these activities, data are generally not available on the numbers of participants or the funds expended in these programs.

The Army and Navy, through the Army Research Office and the Office of Naval Research respectively, have made a concerted effort to stimulate and encourage the future technical development of our nation's youth through involvement in the national science fair program, which typically attracts about 100,000 students annually. The Army contribution to the program, the ARMY SCIENCE FAIR program, involves the award of 1st and 2nd place prizes at each of the 350 state and regional science fairs, and awards in each of 13 categories at the national fair. Trips to international fairs in London and Japan are provided to winners in the U.S. national fair. Total awards amount to \$50,000. The NAVY SCIENCE AWARDS program follows a similar format with awards totalling \$200,000.

An example of a more structured approach to these activities is the ADOPT-A-SCHOOL program carried out by many DoD facilities. An example of this type of program is one initiated in school year 1989-90 by the Defense Nuclear Agency, in which the George Washington Junior High School was "adopted" by agreement with the Alexandria, VA public school system. Thirty-six DNA employees have volunteered to support the school by tutoring students; providing assistance on math/science research projects; judging science fairs; participating in career day presentations; lecturing on math/science/technology subjects; hosting Honors Teas for students and parents; providing instruction to students and staff on the use of computers in science and math; and serving as mentors for the students. Adopt-A-School programs were established in 1983-84 in many locations following a memorandum from President Reagan to the Federal departments and agencies. Vigorous Navy programs were established in the San Diego and Great Lakes areas in 1984. Statutory authority for the program was provided by Section 911 of Public Law 101-165, the Department of Defense Appropriations Act for Fiscal Year 1990, which directed the Secretary of Defense to review partnerships with schools programs; designate a senior official in each of the Services to be responsible for developing these programs; and encourage the participation of all DoD personnel in such programs where they serve as unpaid volunteers under the direction of professional staff in the schools. Supporting testimony for the Bill, published in the Record accompanying the Appropriations Act, noted that there were 275 Partnerships-with-Schools programs nation-wide, with 75 in the



Florida area as a result of Navy initiatives there. However, none of these programs was reported in the survey.

A more comprehensive stimulation program is the JUNIOR SCIENCE AND HUMANITIES SYMPOSIUM, the first and largest pre-college program sponsored by DoD. The program, initiated in 1957 and administered by the Army Research Office, consists of two to three-day regional meetings, which include presentations of papers on research performed by the students; tours of research facilities; a keynote talk by a prominent scientist; discussions on current issues in science; career guidance; and discussions on the relationship of science and the humanities. The program reaches approximately 10,000 students and 250 teachers annually. Ninety-eight percent of the participants go on to attend college but no data are available on the number that pursue careers in science or technology.

The TEXAS PRE-FRESHMAN ENGINEERING program (TEXPREP) is similar in scope but was established by a consortium of state and local governments, colleges and universities, federal agencies, and private industry in the state of Texas. The program involves academic instruction and tours and presentations on science and engineering subjects to students in grades 6-11 who have high potential for science or engineering careers. Defense Mapping Agency supports the program by providing salary support for 12 college student Aids to the program who are employed at DMA under the Summer Aid Program (Federal Personnel Manual (FPM) Ch. 332, Appendix J) and by hosting tours of their facility. The program has a high percentage of women and minority participants (91 percent in 1989) and has had an outstanding success rate in encouraging students to attend college (90 percent), and of those attending college to pursue careers in science and engineering (60 percent).

C. PROGRAMS TARGETED TO STIMULATE INTEREST IN SCIENCE AND TECHNOLOGY CAREERS AMONG MINORITIES, WOMEN AND HANDICAPPED PERSONS:

Activities pursued in this category are very similar to those described above but are targeted for women, minorities, and handicapped persons, groups which are traditionally less likely to pursue careers in science or engineering. The DoD also has broader authority to conduct programs in this area under the direction of Executive Orders and the EEO programs implemented to carry out these orders.

The UNINITIATED INTRODUCTION TO ENGINEERING (UNITE) program, administered by the Army Research Office, provides a four-week intensive experience, primarily for minorities (98 percent), but not exclusive of other disadvantaged youths. The programs are conducted at eight universities distributed across the U.S. and consist of academic instruction on trigonometry, pre-calculus,

computer science, physics, chemistry, and communication skills. Tracking from this and similar programs indicates that approximately 80 percent of minority students who enter engineering participated in some type of summer enrichment program.

Other examples of successful pre-college programs conducted at the local level include the MINORITIES IN ENGINEERING and HANDICAP OUTREACH programs conducted by the Naval Air Development Center in Warminster, PA. The MINORITIES IN ENGINEERING program consists of two-hour sessions held every two to three weeks during the school year at NADC. The sessions include, introduction to digital electronics; computer programming; career workshops college information; a tour of the center; and a student project. Evening introduction and graduation sessions are held with the parents. Students are drawn from four local high schools upon recommendation of science teachers and interviews. The program is targeted for minorities and conducted by the EEO office but others are not excluded. A tracking program has been initiated but the results are not yet available. The HANDICAP OUTREACH program targets junior and senior high students with a disability and involves tours of NADC and establishment of a mentor relationship with NADC employees with a similar handicap. The TECHNICAL MENTOR program at Naval Weapons Center is intended to provide support to women, minorities, and economically disadvantaged youths who are under-represented in science and engineering. The program starts with high school juniors who perform educationally related tasks in an unpaid status under the student volunteer program. During their senior year these students are hired as student aides under the Stay-in-School program (Schedule A 213.3102(w)) for a period of one year. The appointments may be renewed if eligibility requirements are still met.

D. PROGRAMS TO STIMULATE INTEREST IN SCIENCE AND TECHNOLOGY CAREERS BY PROVIDING A WORK EXPERIENCE IN DOD LABORATORIES:

The thrust of these programs is to stimulate interest in science and engineering careers through a hands-on work experience in a DoD laboratory and a mentor relationship with an active scientist. A DoD Instruction was issued in 1981 to establish the DOD SCIENCE AND ENGINEERING APPRENTICESHIP PROGRAM FOR HIGH SCHOOL STUDENTS. Students work on research projects in DoD Laboratories or with principal investigators at universities who have DoD research contracts or grants. Since 1981, when the program was concentrated primarily in the Army and Navy laboratories in the Washington, D.C. area, this initiative has grown to include participation by all three Services. A variety of authorities may be used to implement the program with the most flexible being Schedule A, 213.3102(q). The Office of Naval Research administers the local program for the Washington, D.C. area on behalf of the Army and Navy laboratories in the area, via a contract with George Washington University. The contractor provides for recruiting,

screening and matching student apprentices with laboratory mentors. The program placed 667 participants in 24 laboratories and organizations in the Washington-Annapolis area in 1989 for a period of ten weeks during the summer. Teachers can also participate and earn credit with additional weekend lectures prior to the start of the student program. Students and teachers work on real research projects in DoD labs under the tutelage of a DoD civilian scientist. The students and teachers prepare reports on their projects and present the results in a staff seminar. Teachers monitor and coordinate the activities of the students. The Air Force has a similar program for students in the Dayton, OH area which involves an eight-week experience and is called the HIGH SCHOOL APPRENTICESHIP program. Again a contractor is used to help recruit and place apprentices in the Air Force laboratories. There were 103 participants in 1989.

The HIGH SCHOOL APPRENTICESHIP and RESEARCH AND ENGINEERING APPRENTICESHIP (REAP) programs, sponsored respectively by the Office of Naval Research and the Army Research Office, also derive their authority from the DoD Instruction, but rather than placing students in DoD laboratories, these initiatives provide research experiences for high potential high school students in an academic environment. Students are placed with Principal Investigators on DoD research grants and are paid minimum wages during the work period. The Navy had 80 apprentices and the Army had 110 at 56 institutions during 1989 programs. Surveys indicated 85 percent of the REAP students attended college.

The NRL GIFTED AND TALENTED program and the Naval Coastal Systems Center GOULD SCIENCE AWARD provide work experiences for the students over an extended period of time. The Gifted and Talented program of the Fairfax County Public Schools allows high achievement students in their junior and senior years to work in local industry and government facilities. The students work up to 20 hours per week during school and holiday periods at NRL under Schedule A, 213.3102(q) and DODI 3218.1. The Gould Science Award is given to the top science students in three of the NCSC area local high schools and the students are offered a summer appointment following their senior year.

Students with less experience, such as junior high school students, may be allowed use of government facilities for STUDENT VOLUNTEER SERVICES under Chapter 308, Federal Personnel Manual. OPM has relaxed the age limit for the student volunteers to allow 14 and 15 year olds to participate, as long as there is no conflict with state and local child labor laws.

## UNDERGRADUATE LEVEL PROGRAMS

The main purposes of DoD support for undergraduate science and education programs are to provide a supply of college graduates trained in science and engineering for the Services; to provide work experiences for students that may assist in recruiting; and to provide job related training for full-time employees. The largest undergraduate program is the ROTC program which in recent years has selectively sought science and engineering majors. Several of the older summer programs such as STAY-IN-SCHOOL, FEDERAL JUNIOR FELLOW, and SUMMER AID were conceived as means to supplement the incomes of students from low income families who would otherwise not be able to attend college. The COOPERATIVE EDUCATION (CO-OP) program is designed to provide on-the-job work experience and a supplement to income interspersed with full-time academic periods. The newest undergraduate programs are targeted on increasing the number of minority students pursuing careers in science and technology.

### A. PROGRAMS TO PROVIDE SCHOLARSHIP SUPPORT:

All three Services operate RESERVE OFFICER TRAINING CORPS (ROTC) programs at cooperating universities nation-wide under the authority of 10 U.S.C. 2101-2107. There are a total of 850 universities with an ROTC affiliation and 87,000 students participating in ROTC training, most in non-scholarship status. The ROTC program was initiated in 1916 under the Morrell Act, but since 1964 the program has been refocused to emphasize scholarship support and active recruitment of science and engineering majors. The Air Force program in particular recruits 70-80 percent science and engineering majors while the Army program does not emphasize preference. The Army program had 10,350 participants on scholarship in 1989, the Navy had 6,589, and the Air Force had 4,800 for a total of 21,739 on scholarships. Approximately 13,000 (60 percent) of this total are majoring in science, math and engineering fields. Scholarship support of tuition, books, fees and \$100 per month are paid during the school year and summer training and cruises bring the total support to approximately \$8000 per year. Total support for the S&E scholarships amounted to \$105 million in 1989. The graduates are obligated to four years active duty military service but may be commissioned in the reserves depending on force requirements. Reductions-in-force anticipated in the next several years will reduce the total number of officers commissioned through ROTC programs, but the number of scholarships offered is anticipated to remain fairly constant.

The Army has developed an alternative ROTC program called the SCIENCE AND ENGINEERING ROTC CO-OP program, separate from the basic program described above, to recruit scientists and engineers.

Students must be enrolled at one of 145 participating universities that offer a science and engineering curriculum, an Army ROTC program, and have a cooperative education (Co-op) program. The students are eligible for up to \$5000 per year for tuition, fees, and room and board. Participants are also offered co-op jobs at Army labs with additional pay for the work period. Upon graduation, the students are commissioned in the Army Reserves and are obligated to work at an Army lab until a service commitment is met. The program was conducted on an experimental basis for five years and has recently been adopted permanently and transferred to the Army Personnel Command for administration. Initial efforts to recruit for active duty service were not as well received as the Reserve status. The program currently has 216 participants.

**B. PROGRAMS TO PROVIDE RESEARCH EXPERIENCE:**

COOPERATIVE EDUCATION (CO-OP) programs, to provide alternate periods of work experience and academic education, are available at many universities and colleges. The program is usually open to sophomore or junior level students meeting certain academic standards. The program allows more informed choices of career specialties for students as well as providing supplements to their income. The program has proven to be an effective recruitment method for undergraduate personnel and provides an opportunity to evaluate a potential employee's abilities before hiring. Chapter 308, Federal Personnel Manual, "Youth and Student Employment Programs," describes co-op programs for the undergraduate, associate degree, and graduate level. Students in the undergraduate program are appointed under Schedule B, 213.3202(a) which permits up to 1,040 hours of work per year at a GS-2 or 3 level, consistent with their qualifications. Students may be converted to career conditional appointments upon graduation. Components reporting undergraduate co-op programs included Defense Mapping Agency; Naval Sea Systems Command HQ; Naval Facilities Command; and Naval Research Laboratory. Air Force laboratories, National Security Agency, Naval Oceanographic Research Laboratory, and Naval Air Development Center reported the statistics for the graduate and undergraduate co-op programs together.

The STAY-IN-SCHOOL program is intended to provide supplemental income for students who would have difficulty meeting the financial burdens of a college education. The need requirements for admission to the program are established annually by OPM. The program permits high school and undergraduate college students to work up to 20 hours per week during the school year and full-time during summer and holiday vacation periods, not to exceed 1,040 hours per year. Appointments are under Schedule A, Section 213.3102(w) for a period of one year but may be extended for additional periods not to exceed one year. Organizations reporting participation in this program included Defense Mapping Agency and Naval Coastal Systems Center. The FEDERAL JUNIOR FELLOW program

is somewhat similar to the Stay-in-School program but also has a merit requirement for students to be in the top ten percent of their classes in addition to having financial need. Students are appointed upon graduation from high school and work the summer after graduation and succeeding summers and vacation periods while in college. Students are eligible for non-competitive appointment to career conditional positions upon receipt of their degrees. The program is authorized under Chapter 308, Federal Personnel Manual. Organizations reporting Federal Junior Fellow programs include Defense Mapping Agency; Naval Research Laboratory; Naval Air Development Center; and the Naval Coastal Systems Center.

The Naval Research Laboratory makes use of the provisions of Excepted Service Schedule A, 213.3102(q) to hire approximately 80 college or high school students as research aids during summer and holiday breaks or intermittently during the year. The total hours cannot exceed 1,040 per year, hence the name of the program, 1040 HOUR APPOINTMENT.

The SUMMER AID program provides for summer employment of needy youths to provide job experience and allows reappointment of those with satisfactory performance. Applicants must be referred by a state employment agency and are ranked in order of need. The program is described under Chapter 331 appendix J-6 with hiring under Schedule A, 213.3102(v). Defense Mapping Agency and Naval Electronic Systems Engineering Activity use the program.

The SUMMER HIRE program of Naval Research Laboratory and S&E SUMMER EMPLOYMENT program of Naval Air Development Center are merit programs conducted under authority of OPM Regulation 316.402(a). These programs provide summer work experience for students in disciplines of interest to the agency and are highly competitive. The National Security Agency conducts a similar SUMMER PROGRAM, but is given authority for excepted service under Public Law 86-36.

C. PROGRAMS TARGETED TO INCREASE PARTICIPATION OF MINORITIES IN SCIENCE AND TECHNOLOGY CAREERS:

Executive Order 12320 in 1980 and Executive Order 12677 of April 28, 1989, provided for the establishment of programs to strengthen the Historically Black Colleges and Universities (HBCUs) by providing assistance and advice to faculty, and training opportunities for their students. This has resulted in the development of a number of programs such as the HBCU initiative and ADOPT-A-COLLEGE to respond to the Executive Order. Most use the authorities for student employment and OPM excepted service schedules such as those described above, but are specifically targeted on the HBCUs. The Office of Naval Research has developed a comprehensive program to address both the availability of students and faculty research. The Naval Oceanographic Research Center has established an Adopt-a-College program with Jackson

State University and provides summer job opportunities for undergraduate and graduate students and faculty members in science and engineering disciplines. The Naval Air Development Center has targeted about a dozen schools with black and hispanic populations which conduct engineering programs and various NADC departments have adopted each of the schools to establish communication on NADC career opportunities. Students participate in two-day visits to NADC, co-op programs and faculty work in summer research programs. Defense Mapping Agency is just developing a program which will include the usual summer programs, co-ops, and faculty exchange, as well as providing excess equipment to HBCUs and providing opportunities to bid on research contracts.

The ONR HBCU program currently funds \$3.9 million per year in research and scholarship support to HBCUs. Six additional grants for a total of \$14 million over a five-year period were recently announced. The grants to the schools will fund a spectrum of programs including direct scholarship/research assistantship support to more than 100 undergraduate students; faculty research grants; student summer research experiences; visiting scholars; and improved laboratory training. Each of the schools is expected to complement the ONR support with existing programs to stimulate interest and improve teaching of science and engineering in grades K through 12. The ONR program will attempt to reduce attrition at the undergraduate and graduate levels.

The National Security Agency conducts a unique UNDERGRADUATE TRAINING program for minority students to provide educational and conditional employment opportunities. The program requires an SAT score of 1100, a GPA of 3.0 and an interest in science and math fields of interest to NSA. The program pays tuition and incurs an obligation of one and one-half years of service for each year in the program. The program currently has 37 participants and an expansion to 50 is planned for 1990. The program authority is the National Security Act of 1959 as amended by Section 505 of Public Law 99-569.

#### D. PROGRAMS TO PROVIDE JOB RELATED TRAINING FOR EMPLOYEES:

The DoD makes a significant contribution to education in science and technology fields through the training and education programs provided for its own employees who comprise 3 percent of the national pool of scientists and engineers. The basic authority for training programs is contained in 5 USC, Ch. 41 and E.O. 11348 of April 20, 1967. The provisions of these authorities are described in Chapter 410, Federal Personnel Manual. Training may be full-time, part-time, on or off-duty, day or evening. It may be given by the agency itself; an educational institution; another Federal agency; a professional association; or by a manufacturer. Agencies may pay for all or part of the expenses of authorized training. The purpose of training is to provide improved public

service, cost savings, and the development and retention of a cadre of skilled and efficient government employees who are abreast of current scientific, technical, professional and managerial developments. The training must be in fields which are or will be directly related to the performance of official duties for the government. Training covers many activities such as attendance at conferences, short courses, etc. For the purposes of this report, only training activities which provide formal educational course work in science, math, or engineering disciplines at an accredited academic institution (or Agency programs of equivalent stature) will be considered as S&T education programs. Most training programs apply equally to undergraduate and graduate course work and many organizations do not differentiate between them. As a result, it is difficult to separate the participation and expenditure levels between undergraduate and graduate programs.

The Naval Air Development Center offers a PART-TIME UNDERGRADUATE STUDY AWARD program for non-science and engineering employees who wish to pursue a scientific or technical degree. The employee must have already completed one full academic year in the subject field and have career status (three years government service) with one year employment at NADC. Participants may receive up to 20 hours education per week at a local college or university with full pay, tuition and academic fees. Appointment to the program is for one year, renewable until the B.Sc. degree is granted, if progress is satisfactory. An obligation of three years service for each year of training is incurred. The UNDERGRADUATE ACADEMIC program of the Naval Ocean Systems Center offers a very similar program except it is limited to nine credit hours per semester and applies only to upper division courses. The National Security Agency offers an ADVANCED STUDIES program on the 20 hours study-20 hours work format.

The National Security Agency offers an AFTER-HOURS COLLEGE program for up to eight credit hours per semester at a local college in job related courses for both undergraduate and graduate level courses. The Defense Nuclear Agency also reports a similar program for off-site educational opportunities for employees.

The National Security Agency is also authorized by DoD Directive 5100.47 to operate the NATIONAL CRYPTOLOGIC SCHOOL to provide specialized education and training for employees in computer science, electronic engineering, cryptology and related fields. The courses are both undergraduate and graduate level, and are taught during duty hours.

Long-term/full-time training programs which permit residence at a college or university campus are offered by most components although primarily at the graduate level. The Defense Mapping Agency offers their LONG-TERM - FULL-TIME TRAINING program to full-time permanent employees with two years continuous service, a TOP SECRET clearance, high potential, and relevant academic background.



The employees must pursue training in cartography or related disciplines; be willing to relocate; and incur a three-year service obligation for each year of training. In 1989, 4 of 35 participants were enrolled in undergraduate education programs. The Naval Weapons Center offers a LONG-TERM TRAINING program similar to the one above but concentrated in science and engineering fields of interest to NWC, without the requirement for the TOP SECRET clearance and willingness to move. The National Security Agency offers an external training program called the DIRECTED FELLOWSHIP/SCHOLARSHIP program which is similar to the above programs but pays travel expenses and 50 percent per diem after the first 30 days on campus.

Another special type of training program is the Career Intern program which involves rotation of job assignments for entry level personnel intended for administrative, professional and technological fields particularly for positions with management and executive responsibilities. This may also include some educational training as part of the program. Career Intern programs are described in Chapter 361, Federal Personnel Manual and include entry at GS-5,7 and in some cases 9 level and are intended to bring new entrants to the full performance level over a period of several years. Recruiting for positions in the Intern program may be done directly out of college. Examples of this type of program include, the Naval Air Systems Command ENGINEER AND SCIENTIST DEVELOPMENT program; the Naval Facilities Engineering Command PROFESSIONAL DEVELOPMENT CENTER program; the Space and Naval Warfare Systems Command ENGINEER AND ACQUISITION MANAGEMENT program; the Naval Coastal Systems Center NEW PROFESSIONAL DEVELOPMENT program; the Naval Electronic Systems Center ACCELERATED PROMOTION program; and a somewhat less regimented program administered by the Air Force Civilian Personnel Management Center called CIVILIAN SCIENTISTS AND ENGINEERS CAREER program. The costs listed in Appendix B for the career intern programs identified above reflect the complete cost of the programs rather than that part associated strictly with education.

Finally, the National Security Agency offers two programs intended to provide staffing for skilled positions below the B.Sc. level where personnel are in short supply. The GROW YOUR OWN program addresses the need for technician level personnel for collection operations, signals conversion, telecommunications, traffic analysis and computer operations technicians. High school graduates and agency employees are recruited for this program which provides a combination of formal and on-the-job training to bring the participants to the journeyman level of competency. Graduates of the program are obligated to remain in the field for which trained for two years. The COMPUTER OPERATIONS ASSOCIATES program is targeted for community college students in computer science, data processing or computer operations programs. The students are partially supported for a continued educational and on-the-job

training program that leads to an Associate degree and qualification for a GS-5 or 7 position.

## GRADUATE LEVEL PROGRAMS

Graduate level education is the largest area of support by the DoD and is focused on the physical sciences, engineering, and mathematics. These skills are crucial to the accomplishment of the Department's mission, however, there is a shortage of these skills, particularly among U.S. citizens. The graduate level programs include direct support of educational training through fellowships; indirect support through research grants to universities which provide for research assistantships for graduate students; and training programs for DoD employees.

### A. TO PROVIDE EDUCATIONAL SUPPORT THROUGH FELLOWSHIPS:

The DoD provided fellowship support to approximately 540 students in 1989 through programs administered by the Army Research Office (ARO), the Office of Naval Research (ONR), the Air Force Office of Scientific Research (AFOSR), and Defense Advanced Research Projects Agency (DARPA). These programs are all advertised nationally through the distribution of brochures to schools and principal investigators on DoD contracts and grants, through advertising in professional society journals and announcements at professional society meetings. The fellowship programs are authorized as part of the annual appropriation for DoD research programs or, in the case of the National Defense Science and Engineering Graduate Fellowship program, directly in 10 USC 2191.

The AFOSR supports two of the oldest fellowship programs, ADVANCED THERMIONIC RESEARCH INITIATIVE (ATRI) and AIR FORCE RESEARCH IN AERO PROPULSION TECHNOLOGY (AFRAPT), both of which are targeted on critical Air Force needs and are concentrated at a few cooperating schools. The ATRI Fellowship program was initiated in 1977 at Stanford, transferred to University of Utah in 1981, and to UCLA in 1987. It is focused on microwave and millimeter wave thermionic amplifiers and components and requires a B.Sc. in Electrical Engineering and U.S. citizenship as prerequisites. Thesis topics are cleared by an advisory board from UCLA, industry and the Air Force. A stipend of \$14,000 per year plus tuition and fees is paid. To date, of the 69 graduates of the program, 56 are working in thermionics related fields. There are 20 students in the current class and graduates are in high demand. The AFRAPT program is a fellowship co-op program involving AFOSR, industry and university cooperation to provide a supply of critically needed engineers in the aeronautical propulsion field. Participants must be employed by Allison, Textron, Garrett, General Electric or Pratt and Whitney, and attend one of the cooperating universities which include MIT, Purdue, Texas A&M, Princeton, and Penn State. The students are typically selected for the program in June, work at

their respective companies over the summer and begin graduate study in the Fall. Thesis work may be done either at the university or at the supporting company. A monthly stipend of \$1400 per month plus tuition and fees is paid during academic periods and competitive salaries are paid during periods of work at the company location. The program has had 60 trainees since its inception in 1982 and although there is no obligation to continue employment following graduation, approximately half of the graduates are currently employed in the gas turbine industry. Of the current 35 participants, one-third are pursuing Ph.D. degrees and the balance are in M.Sc. programs. The program is considered to be highly effective. The JOINT SERVICES ELECTRONICS COMMITTEE has recently initiated another fellowship program targeting the electronics area. The program started in 1989 at a level of \$90,000 and is intended to increase to \$300,000 in 1991.

The LABORATORY GRADUATE FELLOWSHIP PROGRAM (LGFP) is another AFOSR program designed around the fellowship co-op concept. The program is primarily focused on the physical sciences and engineering, but does include life sciences and behavioral sciences opportunities. Each fellow is assigned to an Air Force laboratory researcher, working in the same area of interest as the fellow, who serves as the fellow's mentor and advisor. Fellows are encouraged to spend the summer period at their sponsoring laboratory. Fellows receive stipends of \$15,000 the first year, \$16,000 the second year and \$17,000 the third year plus tuition and fees. The university department attended by the fellow receives \$2,000 per year. Universal Energy Systems has operated the program under contract to the Air Force. The current contract expires August 31, 1990, and it is anticipated that Southeastern Center for Electrical Engineering Education will continue the program under a new contract. Fellowships are awarded on the basis of merit and are screened by an Air Force advisory committee and the contractor. The program currently has 75 students, and although the program is too new to provide a data base of employment history, there has been only one drop-out from the program to date. It is considered to be very successful in attracting high-potential students to science and engineering disciplines of interest to the Air Force. The Office of Naval Research sponsored ONR GRADUATE FELLOW program is similar in concept and scope to the Air Force program. Targeted fields include the physical sciences; engineering; biological science; oceanography; and cognitive and neural science. Stipends are \$15,000 the first year, \$16,000 the second year and \$17,000 the third year, plus tuition and fees. The students are encouraged to work in Navy laboratories during summer and vacation periods. Approximately 50 awards a year are made on the basis of merit as determined by an advisory panel of technical experts. Approximately 100 Ph.D.s have been earned by participants in the program and an attrition rate of less than 7 percent has been observed. The American Society for Engineering Education is the contractor for the program. Program history, exit surveys from fellows, and evaluations from the selection panels indicate the program is very

successful in attracting high quality students, in retaining them, and in integrating them into the research infrastructure. The Navy plans to continue the program at approximately the present level. The Army SCIENCE AND TECHNOLOGY FELLOWSHIP program, administered by the Army Research Office, was similar to the above Air Force and Navy programs and had 53 and 57 participants respectively, in 1987 and 1988. The program is being phased out in favor of two new fellowship programs (URI and NDSEG) and has only eight fellows left in the program. It will be terminated when they complete their degrees. The Army UNIVERSITY RESEARCH INITIATIVE program has a large fellowship component in the program which in 1989 had a budget of \$3 million and supported 149 fellows. The program, administered by the Army Research Office, is targeted on the physical sciences and engineering and is intended to increase the number of students pursuing careers in science and engineering. The program is planned for a future level of about 130 fellows and funding of \$2.5 million per year.

The NATIONAL DEFENSE SCIENCE AND ENGINEERING GRADUATE FELLOWSHIP (NDSEG) program is the most recent fellowship program and has specific authorization in 10 U.S.C 2191 as amended in 1989. Fellowships are awarded for study and research leading to doctoral degrees in the fields of mathematics, physical science, biological science, oceanography, and engineering. The program is sponsored by the three Services and DARPA and operated by Battelle under contract. The fellows are provided with stipends of \$15,000 per year the first year, \$16,000 the second year, and \$17,000 the third year as well as full tuition and fees for three years. DoD also provides \$2,000 per year support to the fellow's department at the university. Fellows are selected on the basis of merit by panels of experts convened by Battelle in each discipline. Approximately 4,200 applications were received for the first competition, and 126 fellows were selected with support as follows: ONR-39; ARO-31; AFOSR-30; and DARPA-26. The program is planned for support at the level of \$10 million in 1989, \$10.5 million in 1990 and \$11 million in 1991 with selection of approximately 120 fellows per year for the three-year fellowship (forward funded to cover 3 yrs.). The program appears to have been well received and has had high quality applicants.

#### B. PROGRAMS TO PERFORM RESEARCH:

RESEARCH ASSISTANTSHIPS: The DoD is authorized to contract for research and to provide grants in areas of research which are relevant to the mission of the Department. In 1989 DoD funded approximately \$800 million in basic and applied research contracts and grants to universities and colleges (exclusive of R&D centers operated by universities) to conduct research in areas of interest to the DoD. A major subsidiary benefit of this research was the training of graduate students in fields of science and engineering of critical importance to DoD. The most recent National Science Foundation survey of Scientists and Engineers (5), indicated 8,235

full-time graduate students were being supported by research assistantships and other related support in 1987. Assuming a cost of \$19,000 per year for graduate assistantships, the level of support for this mechanism would be \$156.5 million per year. Research programs of DoD are administered by the Army Research Office, the Office of Naval Research, the Air Force Office of Scientific Research, and the Defense Advanced Research Projects Agency and are coordinated by the Office of the Director for Defense Research and Engineering, Research and Laboratory Management. Individual assistantships are selected by the Principal Investigator and the school, and are not limited to U.S. citizens or nationals. This program was initiated by the Office of Naval Research in 1946 and was subsequently expanded to the other Services and DARPA. It has been responsible for the training of a large number of the scientists and engineers who now work in the physical sciences and engineering. Perhaps more than any other DoD program, it has made a major contribution to the nation's supply of highly trained scientists and engineers.

#### C. PROGRAMS TO PROVIDE RESEARCH EXPERIENCE:

Many of the programs that provide research experience at the undergraduate level are also conducted at the graduate level. In particular the CO-OP programs and the SUMMER HIRE programs are used extensively at the graduate level. The reports on these programs did not differentiate between undergraduate and graduate levels of support. The Air Force GRADUATE STUDENT RESEARCH program is an example of a specific program of this type that provides for a ten-week research experience for graduate level science and engineering students. The program is closely coordinated with the Summer Faculty Research program so that the faculty members can supervise the research of the students. Provision is also made for Air Force scientists to serve as advisors in case summer faculty participants are not available for a particular research area. The program is administered by Universal Energy Systems under contract to the Air Force.

Congress amended Title 10 USC in 1982 to add section 2360, which allows the Secretary of Defense to procure by CONTRACT the temporary or intermittent SERVICES OF STUDENTS at institutions of higher learning for the purpose of providing technical support at defense research and development centers. These contracts can be made either directly with the students or with a non-profit organization employing the students. The students are covered by workmen's compensation but are not otherwise considered government employees. No organizations reported the use of this statute in the survey, perhaps because it was not considered a science and technology education program. Other sources indicate the Army Medical Research and Development Command employs about 400 students and the Army Corps of Engineers employs about 350 under this provision. The statute accomplishes much the same thing as the

student employment programs described in Chapter 308, Federal Personnel Manual, although with greater flexibility.

D. PROGRAMS TO PROVIDE SCIENCE AND ENGINEERING EDUCATION FOR EMPLOYEE TRAINING:

Training programs for employees are conducted under the same authority and under the same terms as those previously described for the undergraduate level. The programs basically fall into the categories of tuition support for a few courses, part-time work programs, and full-time, long-term programs. Under conventional OPM training rules, the acquisition of a degree as an end objective is not allowed although the incidental earning of a degree as a byproduct of the training is acceptable. This places the DoD at a disadvantage when compared to most industry benefit packages. The Air Force is evaluating two programs in this area which emphasize the need for academic training as part of the preparation for attaining competence in technical and management positions.

Examples of the short-term tuition support programs include AFTER HOURS TUITION SUPPORT at Defense Intelligence Agency; the TUITION ASSISTANCE program of the Defense Mapping Agency; the NAVSEA INSTITUTE at Naval Sea Systems Headquarters (which offers career specific courses in cooperation with Virginia Tech); INSTRUCTIONAL TELEVISION offered by Naval Ocean Systems Center and Naval Research Laboratory; special ON-SITE EDUCATION CENTER CLASSES provided by arrangement with the University of California at Chico State and Irvine to service employees of the Naval Weapons Center through live and televised graduate and undergraduate classes; and a similar arrangement at the Army Corps of Engineers WATERWAYS EXPERIMENT STATION GRADUATE INSTITUTE in cooperation with Louisiana State, Texas A&M, and Mississippi State Universities.

Examples of part-time study programs include the EDISON MEMORIAL TRAINING program at Naval Research Laboratory, which provides for 24 hours of work per week and 16 hours per week of academic study at full salary after one year at NRL. The opportunity is limited to one year in ten (exceptions granted for two/ten). The GRADUATE ACADEMIC program at Naval Ocean Systems Center is similar with a 20 hour academic/20 hour work program at full salary.

Examples of long-term graduate training programs which allow full-time attendance at school at full salary and tuition, usually after three years of service and with a three-year obligation of continued service for each year of education provided include the MISSION RELATED GRADUATE program at the Army Corps of Engineers; the LONG-TERM GRADUATE TRAINING programs at the Naval Sea Systems Headquarters and the Naval Ocean Systems Center; FULL-TIME GRADUATE EDUCATION program at the Naval Air Development Center; FULL-TIME STUDY program at the Defense Intelligence Agency; and ADVANCED

GRADUATE RESEARCH program at the Naval Research Laboratory. The Naval Research Laboratory offers a slight variant to this format in the SELECT GRADUATE STUDENT program which offers one-half salary support for full-time study after only one year of government service. Several organizations offer long-term training opportunities in specific disciplines critical to the organization such as OPERATIONS RESEARCH SYSTEMS ANALYST FELLOW offered by Headquarters of the Department of the Army and OPERATIONS RESEARCH ADVANCED FELLOW offered by the Army Materiel Command; the DCI EXCEPTIONAL ANALYST offered by the Defense Intelligence Agency; and the COASTAL ENGINEERING EDUCATION program, WATER RESOURCES PLANNING ASSOCIATE and WATER RESOURCES AND ENVIRONMENTAL LAW ASSOCIATE, all offered by the Army Corps of Engineers.

The Air Force has two unique programs that couple recruiting with advanced educational programs. The PALACE ACQUIRE program, using OPM direct hire authority, recruits recent college graduates in engineering disciplines into the Career Intern program and offers them the opportunity to pursue advanced job-related studies which may lead to a M.Sc. degree during the trainee period. The program has been in operation since 1986 with about 50 interns per year, and very satisfactory results. The PALACE KNIGHT program is another program developed and administered by the Air Force Civilian Personnel center which enables personnel to pursue advanced studies in their career field at both the M.Sc. and Ph.D. level. New recruits are hired at the GS-7 level and report directly to their universities as their first duty stations. They usually receive a Masters degree as a by-product of the studies during the the first one to two years, then are assigned to a lab/work position for three years. With satisfactory ratings in their work assignments, the Palace Knight trainees can then return to school to continue their studies, which usually lead to a Ph.D. degree as a by-product of the advanced study. Full salary, tuition, and relocation expenses to the duty station are paid. A continued service agreement of three years for each year of training must be signed prior to employment. The program is scheduled to start in January of 1990 with approximately 100 participants projected per year.



## POST-DOCTORAL AND FACULTY EDUCATION PROGRAMS

Post-doctoral and faculty education programs are primarily in the category of providing exposure to state-of-the-art science and technology for new Ph.D.s, for faculty enrichment, or for enrichment of faculty at minority institutions. Since the programs employ trained scientists and engineers, they are classified as programs where research is conducted. They also serve, however, to introduce faculty to research areas of interest to DoD and, in the case of the post-doctoral fellow programs, are one of the most effective recruiting programs available to the laboratories.

### A. PROGRAMS WHICH PERFORM RESEARCH:

The NATIONAL RESEARCH COUNCIL RESEARCH ASSOCIATESHIP program is one of the oldest education programs supported by DoD, dating back to 1957. The program provided placement for 239 post-doctoral fellows in 17 DoD laboratories and centers during 1989, including all three Services and several agencies. Applicants must be within five years of earning their Ph.D. degrees, and must submit proposals for independent research in their areas of interest. The proposals are screened for relevance by the host laboratory and evaluated and ranked by a panel of experts appointed by the National Academy of Sciences. Fellows selected are given appointments at a DoD laboratory of their choice for a period of one year, with an option of renewal for a second year. An active research scientist at the laboratory is assigned as an advisor. Stipends of \$32,000 to \$34,000 per year plus certain travel allowances and conference fees were paid in 1989. Stipends for 1990 increased to \$34,000 per year with slightly higher rates available for engineers. The program is operated for the Department of Defense by the National Research Council. Authority to place NRC Fellows in excepted service is provided in Schedule A, 213.3102(aa). Most associateships are limited to U.S. citizens, but the Air Force accepts foreign nationals in their program. The NRC post-doc program is highly regarded and has provided many outstanding scientists and engineers for the DoD laboratories and centers.

The Office of Naval Technology supports the ONT POST-DOCTORAL FELLOWSHIP program for selected fields of science and engineering of interest to the Navy. The format is similar to the NRC program, but is administered by the American Society for Engineering Education and provides a slightly more generous stipend. The program had 77 participants in 1989 who were placed at participating Navy labs.

SUMMER FACULTY RESEARCH programs are sponsored by all three Services to provide research experiences in DoD laboratories during the summer months. The applicants must be faculty members at accredited colleges or universities, U.S. citizens and preferably hold or be eligible for a SECRET security clearance. The programs typically run ten weeks and pay stipends of \$900 to \$1500 per week, depending on faculty position, plus travel expenses and a modest relocation expense. Research is performed on a project of mutual interest to the faculty member and the host laboratory. Authority for the programs is covered under Schedule A, 213.3102(o). The Air Force Office of Scientific Research administers the Air Force program through a contract with Universal Energy Systems. There were 150 participants in 1989. The Office of Naval Research administers the Navy program through a contract with the American Society of Engineering Education; 207 faculty were placed at 19 participating Navy labs in 1989. The Army Research Office sponsors a similar program with Battelle as contractor which had 107 appointments at Army labs in 1989. The LABORATORY CO-OP RESEARCH program started by the Army Research Office in 1971 was the forerunner of the Summer Faculty programs. It involved three to six-month sabbaticals at Army labs with full university salary and travel expenses. It is still available but appears to be less popular than the shorter summer faculty program.

The Air Force Summer Faculty program is coupled to a companion program, called the RESEARCH INITIATION program (not to be confused with the University Research Initiative Research Initiation program that uses the same name), which provides grants of \$20,000 per year for research projects that evolve from the Summer Faculty program. The projects are carried out at the faculty member's institution. Proposals are submitted after the summer faculty experience and are evaluated for relevance and merit by Air Force laboratory personnel and the contractor, Universal Energy Systems. This program awards 75 grants per year for a total of \$1.7 million and is useful for stimulating interest in research areas critical to the Air Force mission and in assisting new faculty members and faculty from HBCUs/MIs to gain experience in these areas.

The Air Force also has a special faculty program for long-term exchanges under the authority of the Intergovernmental Personnel Act of 1970 as amended (Public Law 91-648). The UNIVERSITY RESIDENT RESEARCH program provides for the faculty member to spend one to two years at an Air Force laboratory or AFOSR performing research or administration in an area of mutual interest. The applicant must be a full-time faculty member in a science or engineering field, a U.S. citizen, and hold or be eligible for a SECRET clearance. The university must agree to continue employment of the faculty member upon completion of the sabbatical. Salary is shared by the university and the Air Force, and travel and relocation expenses are paid by the Air Force.

The Office of Naval Research YOUNG INVESTIGATOR program is not strictly an education program but is an innovative program designed to assist new faculty members within five years of their Ph.D. in obtaining their first DoD grants. This program is intended to attract capable new faculty members who are outstanding researchers to areas of research relevant to DoD. In 1989, 44 Grants totaling \$2.5 million were awarded.

**B. PROGRAMS TARGETED TO INCREASE THE PARTICIPATION OF WOMEN AND MINORITIES:**

The WOMEN SCIENCE SCHOLARS program, developed by Office of Naval Research, is intended to provide post-doctoral experience for Ph.D. graduate women who are at a point in their careers where this experience can make a critical difference. It is based at Bunting Institute of Radcliffe College with collaboration at other New England schools. The women are paid a stipend of \$25,000 per year for a period of a year. The program is rated highly by the participants and credited with substantially aiding their careers and attracting them to research areas of interest to DoD.

The SUMMER COLLEGE OUTREACH, RECRUITMENT, AND EMPLOYMENT (SCORE) program of the National Security Agency is an affirmative action initiative in support of HBCUs and other minority institutions (MIs). Faculty members of these institutions in engineering, computer science and mathematics fields work at the National Security Agency during the summer months and are introduced to research fields of interest to the agency. The summer experience helps them to keep abreast of current developments in their fields and makes them aware of educational requirements for careers at NSA which should be incorporated in their curricula. It also provides contacts for later NSA recruiting at these institutions.

**SUMMARY**

Table II provides a summary of participants and funding level in thousands of dollars by education level and by purpose of the program for responses received in the survey. It should be noted that the largest programs in terms of funding are the research assistantships and ROTC scholarship programs with \$156.5 and \$106 million, respectively. Targeted programs totaled \$7 million. Employee training, for those programs reported, amounted to \$18 million. This is certainly an underestimate since many laboratories and centers were not reported in the survey.

Some perspective on the education investment at a research laboratory can be gained from Table III which provides a break-down on programs supported at the Naval Research Laboratory, Washington, D.C. In 1988, NRL had 3,576 employees with 497 B.Sc., 323 M.Sc., and 729 Ph.D.s. This table provides a comparison of the magnitude

of various programs and a basis for estimating an approximate support level for various programs such as Co-op, NRC Post-Doc, SEAP, Summer Faculty, etc.

Tables IV and V provide summaries of the participation and funding level for fiscal year 1989 for various types of program supported by the research program and personnel offices. Table IV is based on the data in Appendix B and is relatively complete. Table V is based on the data in Appendices B and C and contains estimates of cost where actual figures were not provided. It represents a lower limit for the various programs listed.

TABLE II

SUMMARY OF SCIENCE AND ENGINEERING EDUCATION PROGRAM  
PARTICIPATION AND FUNDING - FY 1989

	<u>PARTICIPANTS</u>	<u>FUNDING (\$K)</u>
PRE-COLLEGE LEVEL		
IMPROVE QUALITY	5128	793
STIMULATE CAREER INTEREST	12,247	1,137
PROVIDE EXPERIENCE	968	1768
TARGETED	<u>735</u>	<u>108</u>
TOTAL	19,078	3,806
UNDERGRADUATE LEVEL		
ROTC SCHOLARSHIP	13,147	106,331
PROVIDE EXPERIENCE	376	1,516
TARGETED	228	7,088
EMPLOYEE TRAINING	<u>527</u>	<u>7,792</u>
TOTAL	14,278	122,727
BOTH UNDERGRADUATE & GRADUATE LEVEL		
PROVIDE EXPERIENCE	758	2614
TARGETED	3	40
EMPLOYEE TRAINING	<u>20,251</u>	<u>5,457</u>
TOTAL	21,032	8,111
GRADUATE LEVEL		
FELLOWSHIPS	541	20,393
RESEARCH ASSISTANTSHIPS	8,337	157,310
EMPLOYEE TRAINING	<u>1189</u>	<u>6,479</u>
TOTAL	10,067	184,182
POST-DOCTORAL/FACULTY LEVEL		
RESEARCH APPOINTMENTS	933	21,320
TARGETED	<u>13</u>	<u>189</u>
TOTAL	946	21,509
GRAND TOTAL	65,376	340,335

TABLE III

EDUCATIONAL PROGRAMS AT THE NAVAL RESEARCH LABORATORY  
FY 1987, 1988, 1989

<u>PROGRAMS</u>	<u>PARTICIPANTS</u>			<u>FUNDING (\$K)</u>		
	<u>87</u>	<u>88</u>	<u>89</u>	<u>87</u>	<u>88</u>	<u>89</u>
Student Volunteer	1	2	4	0	0	0
Summer Hire	84	58	55	284	205	196
SEAP	79	98	97	91	113	112
Gifted & Talented	2	3	1	5	8	3
1040 Hr. Appt.	85	78	81	674	354	373
Federal Jr. Fellow	14	11	4	48	44	18
Co-op	143	129	119	835	807	700
ONR Grad Fellow (summer)			6			32
ONT Post-Doc.	30	35	40	975	1138	1440
NRC Post-Doc.	60	60	60	1629	1920	1920
Summer Faculty			49			500
Edison Mem. Grad. Training	15	15	8	203	213	266
Select Grad. Training	2	1	3	45	36	85
Adv. Grad. Training	6	3	4	448	191	315
Technical Training (Total no. courses)	1763	1340	1539	530	474	619
Partners in Education, M. V. Leckie Elementary School Washington, D.C.				<u>0</u>	<u>0</u>	<u>0</u>
Totals				5767	5503	6579

TABLE IV

SCIENCE AND ENGINEERING EDUCATION PROGRAMS SUPPORTED BY RESEARCH  
OFFICES (ONR, AFOSR, ARO: R&AT(RLM) COORD.) - FY 1989

	<u>SERVICES</u>	<u>PARTICIPANTS</u>	<u>SUPPORT (\$K)</u>
1. RESEARCH ASSISTANTSHIPS	ALL	8235	\$156,500
2. FELLOWSHIPS			
ONR FELLOWS	N	139	4,100
URI FELLOWS	A	158	3,163
LAB GRAD FELLOW	AF	50	1,661
AFRAPT FELLOW	AF	45	908
ATRI FELLOW	AF	20	465
JT. SERV. ELECT. FEL. ALL	ALL	3	90
NDSEG FELLOW	ALL	<u>126</u>	<u>10,006</u>
TOTAL		541	20,393
3. POST-DOCS			
NRC	ALL	239	7,624
ONT	N	77	2,185
UNIV. RESIDENT RES.	AF	<u>24</u>	<u>1,942</u>
TOTAL		340	11,751
4. FACULTY			
SUMMER FACULTY	ALL	474	5,339
YOUNG INVESTIGATOR	N	44	2,530
RESEARCH INITIATION	AF	<u>75</u>	<u>1,700</u>
TOTAL		593	9,569
5. HBCU/MI			
HBCU/MI*	N	200	6,500
UNITE	A	686	105
WOMEN SCHOLARS	N	<u>6</u>	<u>174</u>
TOTAL		892	6,779
6. PRE-COLLEGE			
H.S. APPRENTICE	ALL	960	1,765
H.S. S&M FACULTY	A	128	543
JR SCI&HUM SYMPOSIUM	A	10000	850
SCIENCE FAIR AWARDS	A&N	1115	250
NATL SCI RES CNTR* DDR&E	DDR&E	<u>5000</u>	<u>300</u>
TOTAL		17203	3,708
GRAND TOTALS		27804	208,700

\* These broad programs affect entire schools to some degree, estimates of participants are long term involvement.

TABLE V

EDUCATION PROGRAMS SUPPORTED BY PERSONNEL AND EEO OFFICES  
FISCAL YEAR 1989

<u>PROGRAM</u>	<u>PARTICIPANTS</u>	<u>(\$K)</u>
Adopt-A-School	275	0
Summer Aid/Stay-in-School	1563	5470
Junior Fellow	329	1316
Summer Programs	1541	5393
1040 Hr. appointment	81	373
Co-op	2260	15830
Targeted	105	501
Career Intern	2958	110646
Training	<u>19700</u>	<u>49920</u>
TOTALS APPENDIX B AND C *	28812	189449

\*Costs are best estimate where not given in Appendices



### SECTION III: PROGRAM EVALUATIONS AND OBSERVATIONS

Several in-depth studies of science and engineering personnel needs and science and engineering education programs in the DoD are currently in progress. One study is evaluating the current programs and will recommend a course of action for the near future. Comments were received on the effectiveness of the various programs and a few of these observations will be included. A second study will examine future supply and demand for scientists and engineers in DoD. A third study will evaluate current education programs to identify the elements for successful programs and recommend directions to meet the challenges of the year 2000. The second and third studies are two-year studies jointly funded by the Deputy Director for Research and Engineering (Research and Advanced Technology) and the Assistant Secretary of Defense for Force Management and Personnel.

As a preface to the discussion of observations on the effectiveness of existing programs it should be noted that the criteria used in evaluating the programs differ with the perspective of the responding organization. Evaluations from personnel offices tend to place the emphasis on the effectiveness of the programs in recruiting and retaining scientists and engineers. For example, pre-college programs tend to be lightly regarded by this criteria because they will not provide an immediate supply of new personnel. Fellowship programs are evaluated on the number of degrees earned and the retention of the graduates in defense-related fields. The part-time research assignments tend to be evaluated on the contribution made to the research effort of the organization, and this judgment is influenced by the overhead and indirect charges assessed against these special positions. Developing criteria appropriate for DoD-wide policy decisions will be a part of the study on future needs.

Among the programs that are most effective for recruiting are the Career Intern programs that recruit from campus for an accelerated promotion track and also provide some advanced education as part of the package. Co-op programs, likewise, are rated as very effective, with recruitment rates of 65-70 percent reported in some organizations. At the advanced degree level, the post-doctoral research associateships are very effective in providing a continuing supply of well qualified graduate scientists and engineers for conducting research in DoD laboratories or under university grants and contracts.

The in-house training programs are generally considered important both for providing educational opportunities for employees and as a recruiting tool. However, these in-house training programs are currently limited by statutory restrictions which do not permit payment of costs associated with obtaining a degree. This restriction, coupled with others limiting an employee

to one year of long-term training in ten years service (or even two years with an exception) makes it very difficult to assist employees to pursue advanced degrees in science and engineering. Educational benefits for private industry are not as restrictive, thus making DoD and federal recruiting in general less competitive with the private sector. A change in training regulations, to permit limited exceptions to these rules for career fields where the government is encountering difficulty in recruiting and retaining employees, is proposed in H.R. 2544 as an Administration goal for all federal agencies and may provide some relief for this problem. The long-standing issue of compensation comparability with private industry is still the major determining factor in retention rate of scientists and engineers in government service.

Among the research office programs, the research assistantships supported by research grants to academic faculty are considered the most effective because the student support is coupled with the needed facilities, and the research is performed in an area of interest to DoD. Fellowship programs with a laboratory tie are next most effective in terms of training students in an area of research of interest to DoD and recruiting the students upon completion of their education. The unrestricted fellowships provide the least return to DoD in terms of direct recruitment of scientists and engineers but they attract more capable individuals in a situation where there is a limited supply of qualified candidates and a fellowship with the least restrictions on future employment opportunities is considered the most desirable.

DoD's investment in science and engineering research and related education programs at HBCUs has increased from about \$2 million in FY 1981 to approximately \$12 million in FY 1989, according to the OSD minority business office. Moreover, efforts are being made to meet the requirements of section 1207 of Public Law 99-661, the 1987 National Defense Authorization Act, which directed DoD to reach a goal of five percent for contract awards to small disadvantaged businesses, HBCUs and MIs. As DoD's support for science and engineering education at the university level is derived from authority to conduct research, the fact that fewer than a third of the 106 HBCUs have graduate programs in science and engineering fields, and only ten offer the Ph.D. degree, circumscribes DoD's relationships with a large number of these institutions. It is clear that a long term effort will be required to build the research capability of HBCUs. This effort must include steps to interest students in science and engineering careers; to provide them with the education needed to gain admission to science and engineering curricula; to build the infrastructure (equipment and facilities) of the science and engineering departments; and to acquaint the faculty with the research and technology needs of the DoD.

Pre-college programs range from short exposure tours, speakers and science fairs to more intense tutoring and summer experience programs. Judged from an education criterion, the most effective are those that influence career decisions for science and engineering, provide the necessary career guidance and a glimpse of the excitement and adventure in a science and engineering career. The high school Apprenticeship Programs provide these elements but tend to be under-publicized and under-funded. Experience programs such as Summer Aid, Stay-in-School, Federal Junior Fellow, Co-op, etc., which provide broad employment opportunities for the high school and undergraduate student, should be refocused to provide these experiences in the science and engineering area. For example, restrictions that discriminate against dependents of federal employees should be removed. In an era when finding enough scientists and engineers is a problem, it is counter-productive to bar participation from a group with a higher than average likelihood of pursuing careers in such fields, particularly with the Federal government. Another observation was that restrictions on payment of travel expenses make it difficult to use co-op programs in recruiting to meet minority employment goals. For example, Puerto Rican university students enrolled in science and engineering fields were interested in participating in co-op programs but could not find the financial resources to travel to and live in the Washington, D.C. area.

Another observation and concern expressed by many of the respondents was that financial support for education and training programs is subject to wide swings depending on the budget pressure. There was nearly unanimous concern that the impending cuts in the Defense budget would result in disproportionate reductions in training and education programs. Another related concern is that enthusiasm for new education initiatives, pursued without the addition of new funds, will eliminate current programs which are judged to be effective. An example of this latter situation was the establishment of the National Defense Science and Engineering Fellowship at the expense of existing research programs which supported research assistantships. There was no net increase in the number of scientists and engineers trained and a proven program was replaced with one which does not couple financial support to the facilities support needed for science and engineering graduate training. The separation of the fellowship support from both a principal investigator working on DoD projects and work experience in DoD laboratories also makes it less effective for recruiting.

## PROGRAMS BEING EXPANDED

The statutory direction requiring this report requested DoD to evaluate its science and engineering programs and identify those planned for expansion. It is premature to recommend expansion of programs since, as mentioned previously, a study is in progress to do just that. Several programs were identified, however, which are already in the process of expansion or initial implementation.

The Army has recently placed the Science and Engineering ROTC Co-op program on a permanent basis after a five-year experimental trial. Constraints on the conventional Army ROTC program do not permit selective recruiting of scientists and engineers for ROTC scholarships. This program addresses the need for increased numbers of scientists and engineers by, a) providing scholarship support for tuition, fees, and a subsistence allowance up to \$5000 per year; b) providing co-op jobs at Army laboratories for additional financial support; and c) providing for commissioning in the Reserve forces rather than active duty. The program is currently offered at 145 colleges and universities that meet the requirements of a strong science or engineering program, an Army ROTC program on campus and a co-op program in operation. Participants incur an obligation for service in the Army Reserves and an employment obligation at an Army laboratory in the ratio of three years service for each year of tuition support provided. There are currently 216 participants in the program. It is considered to be an effective program in terms of providing and retaining trained scientists and engineers but the demanding requirements make it difficult to recruit candidates.

The Office of Naval Research is implementing an initiative to assist HBCUs in strengthening their science and engineering departments. Of the 106 HBCUs, only one-third offer graduate courses in science, math and engineering and only ten grant Ph.D. degrees in these fields. Thus, a long-term comprehensive program, addressing all levels of the educational system will be required to materially increase the number of science and engineering graduates from these institutions. ONR has recently announced an increase in their current \$3.9 million per year program with the award of six new grants for a total of \$14 million over a five-year period. The program includes direct support for more than 100 undergraduate scholarships and research associateships, faculty research grants, summer research appointments for students, and programs for visiting scholars. Each of the schools awarded a grant will complement the ONR research program with pre-college programs to stimulate interest in science, math and engineering career fields and to improve the quality of science and math education at the pre-college level.

The Air Force has indicated that its highest priority personnel program is the Palace Knight program scheduled to begin

in January 1990. The program is designed to address the critical problem of maintaining a supply of scientists and engineers at the entry level for advanced degree positions. The Palace Knight program uses OPM direct hire authority to recruit recent college graduates in the engineering disciplines. Other hiring authorities will be used to recruit college graduates majoring in science fields. The new employees are hired at the GS-7 level and report directly to their universities as the first duty station. They pursue advanced job-related training in their career field and usually receive a M.Sc. degree in one to two years as a by-product of the training. They are then assigned to a laboratory or other work position for three years. With satisfactory performance in their work assignments, they can then return to school to pursue additional advanced training which usually leads to a Ph.D. degree as a by-product of the training. A continued service agreement of three years for each year of training must be signed prior to employment. The program is planned for approximately 100 participants per year on a continuing basis.

The National Defense Science and Engineering Graduate (NDSEG) Fellowship program is the most recent graduate research education initiative. The program was authorized by Congress in 1989 to increase the number of students pursuing advanced degrees in science and engineering fields of importance to DoD. The fellowship pays \$15,000 per year the first year, \$16,000 the second year, and \$17,000 the third year as well as full tuition and fees for a period of three years. The program will provide fellowships for approximately 120 fellows a year with a total of 360 in the program after three years. Support for the program is provided by the Service research offices (ARO, ONR, AFOSR) and DARPA. The program is operated by Battelle under contract to the Services. The initial solicitation for fellows was very well received with 4,200 applications for the 126 NDSEG Fellows selected in 1989. Annual funding for the program was \$10 million in 1989 with an increase to \$11 million anticipated for 1991.

#### EVALUATION OF SPECIFIC CONCEPTS

The statutory direction requiring this report requested DoD to evaluate four concepts. They are:

1. Summer internships at DoD laboratories for pre-college teachers of science, engineering or other technical disciplines.

DoD has two established teacher intern programs and various DoD laboratories have experimented with such programs from time to time. The most successful format appears to be one which provides the teachers with a broad update on new areas of science and science teaching prior to an eight-week laboratory experience. The teachers appear to benefit from exposure to a research environment and the activities of career scientists and engineers; the

opportunity to participate in a research project; exposure to current topics of interest in science and engineering; and the enhancement of scientific knowledge primarily through the academic component.

As this report shows, DoD brings large numbers of high school, undergraduate and graduate students, post-doctoral scholars and faculty researchers into its laboratories for research experiences during the summer. These programs were built gradually over a long period of time. (See Table III which shows the range of participants in summer research experiences at the Naval Research Laboratory as an example.) DoD favors increasing the participation of pre-college teachers of science and math in those laboratories which can productively absorb larger numbers of summer researchers at various levels of capability. These summer internships for pre-college teachers support the President's and the Governors' national goals for education by providing opportunities for teachers of mathematics and science to expand their scientific knowledge.

The joint DDR&E/ASD(FM&P) study of successful intervention programs cited earlier will evaluate the existing teacher programs now underway and explore possible methods of expanding this idea.

2. An award program for exceptional pre-college teachers in sciences, engineering and other technical disciplines.

The Bush Administration, in recognition of the importance of awards programs for exceptional pre-college teachers, has expanded the existing Presidential Awards for Excellence in Science and Mathematics Teaching program to include elementary as well as secondary teachers. The Administration has proposed, in the Education Excellence Act of 1989, that the Congress create an expanded Presidential Awards for Excellence in Teaching Program to encompass an even greater number of exceptional teachers.

Although DoD does not have the expertise or experience in pre-college education to operate an awards program independently, the Department supports existing awards programs conducted by the National Science Foundation and the Office of Science and Technology Policy and would support similar programs which may be developed in the future.

3. A scholarship program for undergraduates in science or technical education who plan to teach those disciplines at the pre-college level.

Scholarship programs for undergraduates in science and mathematics who plan to teach those disciplines at the pre-college level are excellent means for meeting the critical shortage of well-trained teachers in those fields. A number of Bills pending in the Congress include proposals for such scholarship programs to

be operated by the Department of Education and the National Science Foundation. Although the DoD has neither the expertise nor the authority to develop and administer such scholarship programs, it will support the efforts of these agencies. The DoD will participate in the proposed Federal Coordinating Council on Science, Engineering and Technology (FCCSET) Committee on Education and Human Resources which will address the need to increase the supply of technicians and professional science and engineering personnel for the nation. This committee should serve to strengthen interagency coordination, promote more efficient use of expertise in the agencies, reduce program overlap, identify areas of program need, and make more efficient use of limited federal resources.

#### 4. Expanding the Barry Goldwater Scholarship and Excellence in Education Program.

The Barry Goldwater Scholarship and Excellence in Education program was established by act of Congress (20 U.S.C. 4701-4711) as an independent foundation under the executive branch of the U.S. Government with an endowment of \$40 million. The Board of Trustees is composed of two members from the Senate, two members from the House of Representatives, eight members appointed by the President, and the Secretary of Education. The Foundation is currently providing undergraduate scholarships to 137 junior and senior class students majoring in science or math who were chosen from each of the states, the District of Columbia, Puerto Rico and the Trust Territories. The scholarships provide up to \$7000 per year for financial support. In the last competition 1,200 nominations for the scholarships were received. There are other provisions in the Act for graduate fellowships and for honoraria to volunteers in various school systems. The Board of Trustees has elected not to activate these latter programs until the undergraduate scholarship program is well established.

The DoD supports the Barry Goldwater Scholarship program as an example of a program that recognizes and rewards meritorious academic achievement in the fields of science and mathematics. The program should contribute to increasing the numbers of scientists and engineers available and is therefore worth expanding, although the impact on DoD recruiting would be less than the science and engineering ROTC programs operated by DoD for this purpose.

#### Section IV. CONCLUSIONS AND RECOMMENDATIONS

The DoD has substantial experience and resources invested in the training and preparation of personnel for military service. The increasing sophistication and complexity of the weapons systems in use today has forced the Department to train the technicians and managers necessary to effectively maintain and utilize these systems. The development of new systems relies on the science and technology base in the DoD laboratories and the defense industry, and this in turn relies on the new knowledge generated by the university and DoD laboratory research communities. This same basic knowledge is the driving force for national competitiveness, as the discoveries pioneered in Defense research make their way into the commercial market place. Factors which diminish the science and mathematics capabilities of the work force as a whole and reduce the supply of trained scientists and engineers in particular are of vital concern both to the DoD and to the nation.

The DoD has the experience and capabilities to contribute to an improvement in the quality of science and engineering education in the country and to assist in motivating and educating a new generation of scientists and engineers. However, except for those functions relevant to training military personnel to perform their duties, keeping its scientist and engineer work force abreast of current developments, and funding research at academic institutions, the DoD has limited authority to participate in science and engineering education programs that impact the larger community. If the DoD (and other mission agencies) are to participate in the rejuvenation of science and engineering education in the U.S. then they need both the statutory authority to do so and commensurate funding to support the tasks assigned.

The DoD has used the authorities currently available to it in creative ways to recruit and retain scientists and engineers and also to motivate students to pursue careers in science and engineering. Several changes which would make the current system more effective have been identified and will be pursued through appropriate channels:

- a) Remove restrictions against supporting costs of obtaining degrees in employee training programs (limited relief proposed in H.R. 2544);
- b) Provide competitive compensation for DoD scientists and engineers;
- c) Remove restrictions on participation of dependents of Federal personnel in student employment programs; and



d) Review and revise travel regulations pertaining to student employment programs where needed to meet minority employment goals or where critical shortages exist.

Finally, the obvious fragmentation of the education programs when viewed from the broad perspective of this report requires some comment. DoD's license to support science and engineering education programs is derived from multiple authorities which have distinctly different objectives in support of the defense mission, and consequently, are overseen by distinctly different organizations within the Office of the Secretary of Defense (OSD), namely, military education and training, OASD(FM&P/MM&PP); civilian personnel recruitment and training, OASD(FM&P/ CPP); and research and development, ODDR&E. Moreover, responsibility for managing these programs is further delegated via comparable organizational structures within the Military Departments and Defense agencies. Within these organizational structures, education, per se, and science and engineering education as a particular disciplinary subset, may not, in many cases, be a primary function of the offices to which it is assigned.

Nonetheless, we have found that the programs are reasonably well coordinated and function effectively as a result of many years of experience. However, with the growing interest in the impact of the educational welfare of the nation as a whole on DoD (such as education of women and minorities, partnerships-in-education, etc.), there is a need for improved coordination between the three major functions.

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**APPENDIX A**

**SCIENCE AND ENGINEERING EDUCATION PROGRAMS SUPPORTED BY DoD**

PROGRAM NAME	COMPONENT	IMPLEMENTATION UNIT	START DATE	NUMBER FY 89	NUMBER (\$K) FY 89	NUMBER FEMALES	NUMBER MINORITIES	COMMENTS
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**\*\*EDUCATION LEVEL PRE-COLLEGE LEVEL**

**\*PURPOSE IMPROVE QUALITY OF SCIENCE TEACHING**

Summer HS Faculty (BSSMP)	A	ARO	84	128	543			For sci/math teachers. 6-10 wks at Army Labs working on research projects.
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Matl Sci Resources Center	OSD	MSRC	87	5000	250			Study and Pilot testing of Science teaching at Elem school level. Jt. with Matl Acad Sci and Smithsonian Inst. 5yr program. Testing in DoDDs system. Estimate 5000 participated in field testing materials.
*Subtotal*				5128	793			

**\*PURPOSE EXPERIENCE**

Res & Engr Apprentice (REAP)	A	ARO	80	110	300	44	63	Students work with mentor at local University. Mentor receives part of grant fund.
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PROGRAM NAME	COMPONENT	IMPLEMENTATION UNIT	START DATE	NUMBER FY 89	(\$K) FY 89	NUMBER FEMALES	NUMBER MINORITIES	COMMENTS
High School Apprentice Science & Eng. Apprentice Prog	AF N	AF Labs Labs	86 81	103 667	180 1105		192	8 wk. program. Jr/Sr. High teachers work at labs for 10 wk period during summer. Supervise students. Teachers have 8 Saturday lectures prior to experience.
High School Apprentice	N	OMR	81	80	180			HS students work in academic research labs with DoD funded faculty.
Student Volunteer Services Gould Science Award	N N	NRL WCSC	87 74	4 3	0 0	3 3	1 0	Award to top science student in local HS. Offered summer employment.
Gifted & Talented Prog	N	NRL	79	1	3	0	1	Students work in lab during school yr and vacations.
*Subtotal*				968	1768	312	257	

PROGRAM NAME	COMPONENT	IMPLEMENTATION UNIT	START DATE	NUMBER FY 89	(\$K) FY 89	NUMBER FEMALES	NUMBER MINORITIES	COMMENTS
<b>*PURPOSE STIMULATE INTEREST IN SCIENCE</b>								
Jr Sci & Humanities Symp	A	ARO	57	10000	850	4500		43 Regional conferences. 2-3 day meet with student papers, lectures, tours. HS teachers also attend.
Sci & Engr Fair	A	UNITS	59	715	50			350 state and regional fairs, approx. 100,000 students nationally. Army provides awards.
Texas Prefresh-man Engr. Adopt-A-School	DNA DNA	TEXAS DNA	84 89	1096 36	37 0	575	927	Local Jr HS was selected for Tutoring Assistance.
Navy Science Award Program	N	ONR	81	400	200	0	0	Awards are presented at about 400 Science Fairs around the country.
*Subtotal*				12247	1137	5075	927	
<b>*PURPOSE TARGETED</b>								
Uninitiated Intr Engr (UMITE)	A	ARO	80	686	105	295	391	4 wk program. Academics, computers, communication skills.

PROGRAM NAME	COMPONENT	IMPLEMENTATION UNIT	START DATE	NUMBER FY 89	NUMBER (\$K) FY 89	NUMBER FEMALES	NUMBER MINORITIES	COMMENTS
Minorities in Engr	N	MADC	85	25	3	17	24	Volunteers give lectures, tour of MADC, career counseling.
Technical Mentor Prog	N	MWC	80	24	0	14	6	Serve as volunteers Jr. yr, offered summer appt. if successful, renewal by yr is possible. tours, career counseling with role model. 2-3 groups per yr.
Handicap Outreach	N	MADC	88	0	0	0	0	
*Subtotal*				735	108	326	421	
**Precollege Subtotal**				19078	3806	5713	1605	

\*\*\*EDUCATION LEVEL UNDERGRADUATE

\*PURPOSE EXPERIENCE

PROGRAM NAME	COMPONENT	IMPLEMENTATION UNIT	START DATE	NUMBER FY 89	NUMBER (\$K) FY 89	NUMBER FEMALES	NUMBER MINORITIES	COMMENTS
Summer Aid, Stay in School	DMA	DMA		65		34	18	
Co-op	DMA	DMA		8		1	3	
Junior Fellow	DMA	DMA		0		0	0	
Co-op Education Prog	N	MRL	64	119	700	26	22	Students may be hired GS5-7 on completion of BSc
1040 Hr Appointment	N	MRL	78	81	373	20	25	Provides students research experience during summer and breaks.

PROGRAM NAME	COMPONENT	IMPLEMENTATION UNIT	START DATE	NUMBER FY 89	NUMBER (\$K) FY 89	NUMBER FEMALES	NUMBER MINORITIES	COMMENTS
Stay in School	N	WCSC	81	28		20	11	Work 20hr/wk during term, full during summer. Financial need.
Co-op Program	N	NAVSEA HQ	75	20	40			
Co-op Educ Prog	N	NAVAFAC Units	72	16	160	2	7	
S&E Summer Employment Prog	N	NADC	50	16	165	9	2	Research experience during summer.
Federal Junior Fellow	N	NADC	84	12		7	5	Summer and break experience in lab.
Summer Aid Federal Junior Fellow	N	NESEA	78	5		3	1	
	N	NRL	74	4	18	4	4	Selection in Sr., yr. in MS, work summers and vacations at lab. non-comp conversion to govt on completion of MSc. Summers after MS grad.
Federal Jr Fellow	N	WCSC	88	2	60	0	2	
*Subtotal*				376	1516	126	100	
<b>*PURPOSE EXPERIENCE &amp; FELLOWSHIP</b>								
Sci & Engr ROTC Co-op Prog.	A	PERSCOM	84	147	1331	20	33	Pays up to \$5000 for tuition, room & Bd. Incur obligation to Labs for service plus duty in Reserves.
*Subtotal*				147	1331	20	33	

PROGRAM NAME	COMPONENT	IMPLEMENTATION UNIT	START DATE	NUMBER FY 89	(\$K) FY 89	NUMBER FEMALES	NUMBER MINORITIES	COMMENTS
<b>*PURPOSE TARGETED</b>								
EBCU	DMA	DMA	87	0	0	0	0	21 INST, Addresses S&E Education in Min inst.
EBCU Prog	N	ONR	79	200	6500			
EBCU/MI Adopt-a-college	N	WADC	89	11	176	3	11	Combination of co-op, faculty research, research at WADC.
Undergrad Training Prog.	NSA	NSA	88	17	412	5	17	Intend to expand to 50 in 90.
*Subtotal*				228	7088	8	28	
<b>*PURPOSE TRAINING</b>								
Prof Development Center	N	NAVAFAC	64	231	7520	94	55	Career Intern
New Prof Develop Prog	N	NCSC	89	21		8	2	Career Intern Program
AccelerateJ	N	NSA	79	7		1	1	Career Intern
Promotion Prog	N	WADC	78	6	210			
Part-time Educ Prog	N	WOSC	77	4	62	3	0	20hr/wk for 2 semesters, upper div courses.
Undergrad Academic Prog	NSA	NSA	68	206				Targets 5 critical technician skill areas.



PROGRAM NAME	COMPONENT	IMPLEMENTATION UNIT	START DATE	NUMBER FY 89	(\$K) FY 89	NUMBER FEMALES	NUMBER MINORITIES	COMMENTS
Computer Oper Assoc. Prog	NSA	NSA	88	52				Targets Community college students in Computer Opns.
*Subtotal*				527	7792	106	58	
**Undergraduate Subtotal**				1278	17727	260	219	

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**\*\*EDUCATION LEVEL UNDERGRADUATE AND GRADUATE**  
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**\*PURPOSE EXPERIENCE**

Co-op Education Prog	AF	AF units		317		47	41	
Summer Hire Prog	N	NADC	60	63	305	7	14	
Co-op Programs	N	NRL	77	55	196	15	8	Summer work experience.
Co-op Program	NSA	NOARL NSA	77 55	6 253	89 2024	5 57	2 18	80% of coops become full time empl.
*Subtotal*	NSA	NSA	76	64 758	2614	131	83	

**\*PURPOSE TARGETED**

Jackson St Res & Educ Prog	N	NOARL	85	3	40	2	3	Faculty and students perform research at NOARL.
*Subtotal*				3	40	2	3	

PROGRAM NAME	COMPONENT	IMPLEMENTATION UNIT	START DATE	NUMBER FY 89	(\$K) FY 89	NUMBER FEMALES	NUMBER MINORITIES	COMMENTS
<b>*PURPOSE TRAINING</b>								
Civilian S&E Career Program	AF	AF units	88	40	107			
Long Term Full Time Training	DMA	DMA	72	49	400	11	0	
S&E Training Prog	DMA	DMA		80	90			
Engineer & Acquisition Manage	M	SPAWAR HQ	89	529	700	54	89	recruit on campus for program participants.
Engr & Sci Development Prog.	M	NAVAIR	62	162				
Long Term Training Prog.	M	NWC	51	20	193	5	3	
National Crypto-logic School	NSA	NSA	65	17329	180	7153	1825	NCS established by law. Similar to other employee TR programs but with emphasis on cryptology. Part are # of courses taken.
After Hours College Prog	NSA	NSA	65	1500	2600			participants are individual courses taken.
Advanced Study	NSA	NSA	65	507	1100			20 hrs work, 20 hrs academic per week.
NSA Fellowship & Scholarships	NSA	NSA	65	19	47			Includes several resident, non-res, & adv study programs.

PROGRAM NAME	COMPONENT	IMPLEMENTATION UNIT	START DATE	NUMBER FY 89	NUMBER (\$K) FY 89	NUMBER FEMALES	NUMBER MINORITIES	COMMENTS
Directed Fellowship/Scholar	NSA	NSA	65	11	40			on campus out-side Baltimore/DC area. Tuition + Travel + 1/2 per diem after 30 days.
*Subtotal*				20246	5457	7223	1917	
**Undergrad/Grad Subtotal**				21007	8111	7356	2003	

\*\*EDUCATION LEVEL GRADUATE

\*PURPOSE FELLOWSHIP

URI Fellow	A	ARO	87	150	3013			
Natl Def S&E Grad Fellow	A	ARO	89	31	2358			Program being replaced by Nat'l Def S&E Grad Fellow.
Sci & Tech Fellow	A	ARO	85	8	150			
Lab Grad Fellowship Prog	AF	AFOSR	86	50	1661	6	0	Students spend summers in Labs. Mentor in Lab advises on thesis research.
Res in Aero. Prop. Tech Fel	AF	AF	82	45	908	2	0	Graduate Fel. co-op program: MIT, Purdue, Texas A&M, Princeton, Penn St.-Univ., with Allison, Textron, Garrett, GE, Pratt & Whitney-Industry.

PROGRAM NAME	COMPONENT	IMPLEMENTATION UNIT	START DATE	NUMBER FY 89	(\$K) FY 89	NUMBER FEMALES	NUMBER MINORITIES	COMMENTS
National Defense S&E Grad Fel	AF	AFOSR	89	30	2540	9	0	
Adv. Thermionic Research Fel	AF	AF	77	20	465			
Jt. Svcs. Electronics Fellow	AF	AFOSR	89	3	90			Funded by Jt. Svcs. Electronics Committee. Increase to \$300K/yr. by '91.
Matl Def S&E Grad Fellow	DARPA	DARPA	89	26	1718			
OWR Grad Fellow-ship Prog	N	OWR	82	139	4100	43	18	
Matl Def S&E Grad Fellow	N	OWR	89	39	3390	12	5	
*Subtotal*				541	20393	72	23	
<u>*PURPOSE PERFORM RESEARCH</u>								
Grad Student Research Prog	AF	AF labs	82	102	810			10 wk summer program. Work with summer faculty profs or AF scientist at AF labs.
Research Assistant-ships-Gen'l	All	OWR, ARO AFOSR	46	8235	156500			Estimate numbers from MSP data. \$K estimated at 19K ea.
*Subtotal*				8337	157310	0	0	

PROGRAM NAME	COMPONENT	IMPLEMENTATION UNIT	START DATE	NUMBER FY 89	(\$K) FY 89	NUMBER FEMALES	NUMBER MINORITIES	COMMENTS
<b>*PURPOSE TRAINING</b>								
Mission Related Grad Prog	A	Corps of Engrs.	80	26	1713			
Water Resources Planning Assoc	A	Corps of Engrs.	80	12				
Operations Res Syst Anal Fel	A	HQDA	85	8	280	2	1	6 mo. program. Operations Research specialty.
Operations Research Adv Study	A	AMC	89	5	284	1	1	curriculum at 10 approved universities with Operations Research Programs.
Water Resources & Environ Law	A	Corps of Engrs.	80	2	132	0	0	GW Univ Law + 10hr per wk in Off of Chief Counsel, USACE.
Coastal Engr Educ. Program	A	Corps of Engrs.	75	0	0	0	0	Offered at Texas A&M every 3yr. 9mo on campus 3mo at Coastal Engr. Ctr, Vicksburg, MS Courses at Co-op univ.
WES Grad Institute	A.	Waterways Expt Sta	87	0	0	0	0	
Palace Acquire	AF	AF	86	49	709	17	20	
Palace Knight	AF	AF	90	0	0	0	0	

PROGRAM NAME	COMPONENT	IMPLEMENTATION UNIT	START DATE	NUMBER FY 89	(\$K) FY 89	NUMBER FEMALES	NUMBER MINORITIES	COMMENTS
Full-Time Study Program	DIA	DIA		0	0	0	0	1 yr Program.
After Hours Tuition Support	DIA	DIA		25	5			2 Courses per year local
DCI Exceptional Analyst Prog	DIA	DIA						Sabatical program. May include education.
Tuition Assistance Grad Study	DMA DRA	DMA DRA	72	300	80	84	24	
NAVSEA Institute Calif State Univ on-site	N	NAVSEA HQ	80	425	104			
Instructional TV	N	NWC	77	201	626	31	15	Arrangement for on-site and TV courses at China Lake which is remote site.
Edison Memorial Grad Training	N	NOSC	84	38	72	8	9	On-site. San Diego St. and Penn St.
Graduate Academic Progr	N	NOSC	77	30	343	6	4	16 hrs academic/24 hrs work at full salary.
Full time Grad Educ	N	NADC	65	21	800	4	0	20 Hr/wk max
Long Term Training	N	NAVSEA HQ	75	10	670			
Adv Graduate Res Program	N	NRL	64	4	315	0	1	Full-time study at full salary.
Select Graduate Program	N	NRL	67	2	85	0	0	Full-time study at 1/2 salary.

PROGRAM NAME	COMPONENT	IMPLEMENTATION UNIT	START DATE	NUMBER FY 89	(\$K) FY 89	NUMBER FEMALES	NUMBER MINORITIES	COMMENTS
Long Term Training	N	NOSC	77	0	0	0	0	Full time for 2 semesters. Salary + Tuition.
*Subtotal*				1164	6479	164	79	
**Graduate Subtotal**				10042	184182	236	102	

\*\*EDUCATION LEVEL POST-DOCTORAL/FACULTY

\*PURPOSE RESEARCH

Summer Faculty	A	ARO	83	107	1089	7	33	Univ. Faculty work in Labs for 12 wk period. Salary + travel.
NRC PostDoc Lab Co-op Res Prog	A	LABS	57	94	3008	5	6	1-2 yr appointments
	A	ARO	72	10	160	0	0	Pre-cursor to summer faculty . Prog. 3-6 mo. in Labs. Pay salary + travel.
Summer Faculty Research Prog	AF	Labs	75	150	1700			10 wks
Research Initiation Program	AF	AFOSR		75	1700			Proposals submitted from SFRP programs. \$ based on salary. Estimate
NRC PostDoc	AF	Labs	58	32	1024			
University Resident Res Prog	AF	Labs, AFOSR	77	24	1942			1-2 yr assignments.
NRC PostDoc	DNA	DNA		5	136	2	0	

PROGRAM NAME	COMPONENT	IMPLEMENTATION UNIT	START DATE	NUMBER FY 89	(\$K) FY 89	NUMBER FEMALES	NUMBER MINORITIES	COMMENTS
Summer Faculty Res Prog	N	Labs	79	207	2390	17	35	Research experience at Navy. Labs during 10 wk summer appointment.
NRC PostDoc	N	Labs	57	108	3456			
ONT PostDoc	N	OMR	84	77	2185			
Young Investigator Prog	N	OMR	85	44	2530			Grants of \$50K/3yrs to new faculty for research in areas of Navy interest.
*Subtotal*				933	21320	31	74	
<b>*PURPOSE TARGETED</b>								
Women Science Sholars	N	OMR	80	6	174	6	0	Radcliffe College and cooperating schools.
Summer Col Outreach (SCORE)	NSA	NSA	87	7	15	0	7	Targets new faculty at HBCU/MI. Summer appts.
*Subtotal*				13	189	6	7	
**Post-Doctoral/Faculty Subtotal**				946	21509	37	81	
***Grand Totals***				52351	235335	13602	4010	



APPENDIX B

SUPPLEMENTAL INFORMATION ON SCIENCE & ENGINEERING  
EDUCATION PROGRAMS

	<u>Service</u>	<u>Unit</u>	<u>No.'89</u>	<u>\$M'89</u>	<u>No. Fem.</u>	<u>No. Min.</u>
Stay-in-School	A	All	4057	-	-	-
Summer Aid	A	All	1465	-	-	-
Federal Jr. Fellow	A	All	246	-	-	-
Summer Employment	A	All	1406	-	-	-
H.S. Co-op	A	All	329	-	-	-
Summer Faculty	A	All	123	-	-	-
HBCU Faculty	A	All	18	-	-	18
Career Intern (S&E)	A	All	1968	-	418	564
Undergrad/Grad Co-op (S&E)	A	All	805	-	-	-
Co-op (S&E)	AF	All	354	-	-	-
Co-op (S&E)	N	All	840	-	-	-
ROTC (All Scholarships)	A	All	10350	-	-	-
ROTC (All Scholarships)	N	All	6589	-	-	-
ROTC (All Scholarships)	AF	All	4800	-	-	-
ROTC (S&E Scholarships)	All	All	13000	105	-	-