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STUDY OF SCIENTISTS AND ENGINEERS IN DOD LABORATORIES

CONDUCTED BY

THE DOD LABORATORY MANAGEMENT

TASK FORCE

PERSONNEL AND MANPOWER WORKING GROUP

NOVEMBER 1981 - APRIL 1982

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NOVEMBER 1981 - APRIL 1982

OFFICE OF THE UNDER SECRETARY OF DEFENSE

WASHINGTON D C 20301

RESEARCH AND
ENGINEERING

FOREWORD

The growing concern in recent years of projected scientific and technical personnel shortages, and the potential impact such national shortages may have on the nation's defense posture, prompted this in-depth examination of the status of DoD's laboratory scientists, engineers and technicians.

Conducted by the Personnel and Manpower Working Group of the DoD Laboratory Management Task Force (LMTF), this study represents an important first step in DoD's efforts to understand national issues surrounding the supply and demand of scientific and technical personnel and the relation of such issues to DoD's ability to attract and retain the highly specialized scientific and technical manpower required by our laboratory community.

The DoD laboratories, clearly one of our most valuable resources, employ almost a quarter of DoD's scientists and engineers. If we are to maintain our scientific and technological advantage, the health of the laboratories and the vitality of their work force must be maintained and supported.

A major finding of this study is that many of the problems now hampering our ability to recruit and retain scientists and engineers are not necessarily related to national supply/demand trends, or to current shortfalls of trained scientific and technical personnel. Rather, some of these problems are of our own making, and therefore, the solutions to them are under our control.

During the coming year, I intend to implement the study's recommendations. As we do so, I look forward to receiving the same excellent cooperation from the Military Departments and their laboratory communities which we enjoyed throughout the conduct of the study itself.

Edith W. Martin
Deputy Under Secretary of Defense
for Research and Engineering
(Research and Advanced Technology)

September 1982

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EXECUTIVE SUMMARY

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This report, "Study of Scientists and Engineers in DOD Laboratories," was conducted by the DOD Laboratory Management Task Force, Personnel and Manpower Working Group, from November 1981 through April 1982. It was undertaken in response to a request from the Deputy Under Secretary of Defense for Research and Engineering (Research and Advanced Technology) to determine the status of scientists and engineers within the DOD laboratories. Subjects that were addressed included: the population and employment of scientists and engineers, education and salary, vacancies, recruitment and retention, and training. Data were developed in parallel for laboratory technicians. The study was asked to make a determination of the need for a broader investigation of all scientists and engineers throughout the DOD.

In assessing the status of scientists and engineers in the approximately 70 defense labs, it is clear that the three separate service lab systems have separate and unique characteristics. Likewise, there are differences among individual service labs. The study has elucidated the variations in type of work, the uses of S&E personnel, the variation in numbers of military S&E, and many other distinct characteristics. In general, over the period 1977 to 1981 the lab S&E work force has remained relatively stable; and within a few percent, the total lab population, the S&E population, the S&E educational levels, and S&E grade levels have all remained constant. Navy total population and high grades have continued a decline of 1-2% per year. Only the entry level S&E have increased over the 1977-81 time frame. At the same time, data

available to this study indicate that the S&E work force has maintained generally good quality and currency. We have examined attrition from the S&E population by grade level, and find the departure rates to be reasonable. Because of the substantial populations of GS-12 and -13, the majority of attrition occurs at these levels. As a result there are significant losses at these critical levels which are hard to replace. There appears to be concern about the relatively slow promotion rate, especially at the higher grade levels, but this is the price paid for a stable work force. As we compared the DOD lab S&E population to nongovernmental S&E populations, the labs show approximately similar educational distribution as compared to the national S&E population, but the labs not unexpectedly have a somewhat skewed distribution of disciplines in favor of the engineering and high technology skills. We have noted comparatively few computer scientists in the DOD lab work force. The "computer scientist" job series does not properly account for the total computer professionals within the DOD laboratories. Many are subsumed for example under engineering job series titles. The lab S&E work force is approximately five years older on average than the national S&E population; over the last three years, the average lab S&E age has remained relatively constant. In spite of special entry salaries for DOD lab engineers, there is a substantial shortfall within DOD labs compared to industry. This trend reverses past age 43, with the labs on average ahead. If industry salaries are compared to those at DOD labs at equal levels of responsibility, laboratory salaries lag at all grade levels. Also DOD S&E have suffered a higher relative decline in salary due to inflationary effects.

Our findings show some selected skill shortages in the DOD lab work force. These shortages are mostly well within the annual attrition rates, and as such do not raise any special alarms of major impending problems. In the context of predicted national shortages, it is thus mandatory that the DOD lab community maintain a watchful eye on the status of its ability to recruit and retain a quality S&E work force. There is nothing in this study to date that indicates that a major problem exists or is developing in the DOD lab community. Perhaps the first pressure point may be difficulty in maintaining the lab Ph.D. or Masters populations owing to the decline of U.S. citizen graduates in these categories. Another area of some concern is computer professionals considering the strong projections of shortages coupled with the laboratory projections for enhanced activity in information-related technologies. The problem is exacerbated in that there is no definitive assessment of computer professionals through the normal job series categorization. One avenue available to the labs to deal with shortages are the excellent training programs extant in DOD. Our study has found that long-term training could be greatly expanded to address shortages as they become apparent, as well as to enhance the currency of the technical work force. This approach appears superior to having the labs sponsor national level programs in that they are less than one percent of the national S&E work force. One additional basis for a conservative approach at the present time derives from the uncertainty of future S&E national shortages, since such shortages are very closely linked to the future economic picture, a subject of much speculation and unpredictability. The study panel believes that there are a great variety of improvements which could be made to enhance the DOD labs S&E recruitment and retention posture and these are quite exclusive of shortages.

The DOD labs have reported significant adverse impact of the controls on personnel ceilings and high grades. Overall personnel ceilings are a reality requiring continued management attention. As such, some fairly difficult management choices have to be made. Ceilings by themselves are not an intrinsic barrier to maintenance of an effective S&E work force beyond a critical mass required to operate a laboratory. What does appear to be important is the maintenance of a stable ceiling consistent with workload to facilitate planning and management within the DOD labs. On the matter of high grade controls for GS-13 to GS-15, the study findings indicate that overall the numbers approach 50% of the S&E population; however, wide variations exist among labs and services. An analysis of laboratory workload has not been undertaken in connection with this study. Judgments on the adequacy of ceilings, both total and high grades, can therefore not be made based on the quantitative data collected. The majority of Technical Directors did report significant adverse impact of high grades and total ceilings including reduced ability to meet mission requirements, deletion of specific technologies that should be addressed, reduced ability to hire and promote experienced and deserving personnel as well as overall reduced quality of work.

There are a number of areas where problems exist and directed action is needed. Maintenance of the currency of the technical work forces is mandatory in light of the rapid rate of technological progress. A comprehensive approach to continuing education is needed. Recruitment at the key journeyman levels, GS-12 and GS-13, will require special attention, particularly due to the relatively low promotion opportunities. The study has developed data that clearly show that a special effort is required to reduce the number of senior executive vacancies. Furthermore, management attention is indicated in addressing relatively high civilian vacancy rates which exist at certain laboratories and in the military S&E assigned to the laboratories. The subject of bureaucratic constraints has been amply addressed in other studies as well as here. Clearly forthright and forceful actions are required to turn the clock back on many of these impediments both to recruitment and retention as well as to improved efficiency and productivity within the DOD labs. We have shown in this study, for example, the absurd time delays that encumber the hiring process. An improvement in this one area would go far beyond any problems which now exist as a derivative of national shortages. The high vacancy rates for senior executives, for example, are undoubtedly related to the long and tedious process for recruitment. If the DOD labs are to attract and retain quality people, the image of the federal worker cannot continue to be diminished. There must be a renewed awareness of the destructiveness of the process which denigrates a work force which is so critical to national security. The study has found that there is a general allegiance to the dual-career concept of professional advancement through scientific and engineering pursuits as well as through management avenues; however, there is much room for improvement in practice to achieve a truly dual path to the most senior grade levels. Finally, the study in a number of instances has found a fairly wide gulf between perceptions about the DOD lab S&E work force and quantitative data which provides specific information on the overall status of the lab S&E. Chief among these were an inability to recruit at the entry level, declining quality, and unhealthy attrition levels. There are, of course, variations over the DOD labs as we have pointed out earlier and, accordingly, each laboratory must take a close look at its circumstances in light of the overall lab environment.

Following from the general findings and conclusions of this study, the panel has made the following recommendations:

Forecast S&E Needs. An annual forecast should be maintained of projected long-term S&E needs of the DOD labs in anticipation of future shortfalls. This forecast should serve as a basis for directed recruitment and training programs. Each of the service lab management offices should monitor the process so that data are assembled in a common format to facilitate exchange of information among services, and to take corrective action as may be appropriate (e.g., more timely adjustment of noncompetitive salaries). In particular, high priority should be accorded to monitoring the status of computer professionals in the DOD laboratories, and to taking aggressive action to adjust compensation levels as needed.

Establish Recruitment Data Base. Services should establish compatible data bases to allow DOD labs to exchange information on S&E candidates available for employment.

Improve Entry-Level and Journeyman Recruitment. Labs should develop imaginative entry-level recruiting programs through active use of special programs and authorities already available:

- Cooperative education
- Summer employment of students
- Federal Junior Fellowship Program
- DOD Science & Engineering Apprenticeship Program
- College relationship efforts
    - Formal & informal contacts
    - Research & grant programs
    - Sec. 603, Title VI, DOD Authorization Act of 1982
    - Faculty appointments
    - Graduate student appointments
    - Student volunteer service.

Laboratories/services should develop a focused recruiting program to attract qualified journeymen (GS-12/13) with skills in shortage areas.

Special effort should be made to target underrepresented groups, such as women.

OSD and services should support proposed legislative initiative to broaden application of the Navy Personnel Demonstration Project.

Address Selected Vacancies. Management attention is needed to address large vacancy rates which exist in all service laboratories in the senior executive positions, in the civilian S&E work force at certain laboratories (predominantly the Army), and in military S&E assigned at the laboratories.

Address S&E Shortages Through Training Assignments. The Government Employees Training Act (1958) and other authorities provide wide latitude in training of personnel. One of the most effective means of handling S&E shortages in critical disciplines is through planned training for selected personnel. Service laboratory management should design aggressive long-term training programs to develop experienced S&E. Both funds and billets should be fenced within the services for this purpose.

Address S&E Shortages Through University Funded Programs. DOD technology base funding at universities should take explicit account of current and projected shortages of specific S&E disciplines at the DOD laboratories. These considerations should impact decisions on DOD-sponsored university fellowship programs as well as specific categories of R&D funded at the universities. Programs which either encourage DOD laboratory employment or require a laboratory commitment as the quid pro quo for university support should be considered explicitly by consultation between Service technology base managers and Service laboratory management offices.

Improve Dual Career Program. Laboratory directors should implement a realistic dual (supervisory/management vs. research) career path and apportion high grade billets accordingly. This may require organizational changes to increase span of control of supervisors/managers and eliminate small organizational entities created primarily to justify high-grade supervisory billets.

Improve Image of Civil Service. DOD management should enhance retention by promoting the value and image of federal employment at the DOD labs. Measures include, but are not limited to, policies for treatment of S&Es as professionals, acknowledgement of significant work by appropriate S&E recognition, and suitable advertisement of laboratory contributions both to the defense and civil sectors. As a further positive contribution, maximum restraint should be exercised by all officials to avoid pejorative comments pertaining to civil servants as a group which reflect both unfairly and inaccurately on individuals within the service.

Reduce Bureaucratic Constraints. Management should systematically identify bureaucratic constraints, and should seek remedies at the proper levels, including statutory redress as appropriate. This report identifies specific constraints requiring concerted and immediate action. The "Personnel Demonstration Project" now being conducted within the Navy is a principal positive contribution.

Review High Grade Distribution. Across DOD laboratories, justification for high grade relief does not appear credible in every case. Services should review high grade ceiling allocation to their laboratories and distribution among laboratories.

Postscript. In a number of instances, perceptions concerning the laboratories were not supported by numerical data. It is in the best interest of the laboratories that lab management be aware of these inconsistencies and understand the underlying rationale for them, particularly in the context of the considerable variation among individual laboratories.

These recommendations are best implemented by the Services through their respective laboratory management offices working in concert with one another. The OSD has a particularly important role in lending support in those areas where Congressional, OSTP, OMB, OPM intercession is required. Examples include initiatives to correct non-competitive entry level salaries (as shown in this report) and to eliminate bureaucratic constraints within OSD control or through OSD influence outside of DOD. The OSD also has an important role to play vis-a-vis the long-term viability of scientists and engineers within the laboratories (as well as the larger defense establishment) by general coordination and support of specific programs of the National Science Foundation. Finally, the study panel was not convinced of the need for further study of scientists and engineers within all of DOD, since 60 percent of the total complement of civilian scientists and engineers within DOD were covered collectively in the Joint Logistics Commanders' study of engineers in their commands, and the scientists and engineers studied in this report in the DOD laboratories. Because of the importance of computer-related specialties to DOD, the potential shortfalls of various computer subspecialties, and the expected significant future growth of computer-related interests, OSD should consider conducting an in-depth study of the status of computer professionals throughout all of the Department of Defense with particular emphasis on job series designations, salaries, and current and projected needs.

ANNOTATED BRIEFING

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ANNOTATED

BRIEFING

STUDY OF SCIENTISTS AND ENGINEERS IN DOD LABORATORIES

CONDUCTED BY

THE DOD LABORATORY MANAGEMENT TASK FORCE

PERSONNEL AND MANPOWER WORKING GROUP

NOVEMBER 198! - APRIL 1982

CHART 1

This study to determine the status of Scientists and Engineers in Department of Defense Laboratories was conducted by the Personnel and Manpower Working Group of the Laboratory Management Task Force. This report gives the results of the study, conducted between November 1981 and April 1982.

STUDY OF SCIENTISTS AND ENGINEERS (S&E) IN DOD LABORATORIES

CONDUCTED BY

THE DOD LABORATORY MANAGEMENT TASK FORCE (LMTF)

PERSONNEL AND MANPOWER WORKING GROUP

NOVEMBER 1981 - APRIL 1982

CHART 2

This chart shows the organization of the briefing.

OUTLINE

CHART 3

The Study Introduction presents the charter for the Study, the Study membership, the approach employed, and an important caveat as pertains to the results.

I. STUDY INTRODUCTION

I. STUDY INTRODUCTION

CHART 4

This study was conducted in response to a memorandum signed by the Deputy Under Secretary of Defense Research and Engineering for Research and Advanced Technology on 5 November 1981. That memorandum requested that the status of scientists and engineers in Department of Defense laboratories be determined with respect to national trends. It also asked that individual laboratory peculiarities with respect to recruitment and retention be identified along with, as far as possible, the reasons for those differences, and that future needs for scientists and engineers be identified and recruiting and retention programs in use be evaluated. Finally, the memorandum asked that, if appropriate, a recommendation for a broader study of scientists and engineers within the Department of Defense be made.

The objective of the study group has been to identify real problems in the availability of scientists and engineers, and to make appropriate recommendations for correcting those problems.

Our approach to the study consisted of three steps. The first was to gather data. This was a major undertaking involving an analysis of five years of data from the Defense Manpower Data Center data base. It also included canvassing the laboratories by means of a detailed questionnaire which covered personnel authorization and inventories, recruiting and retention experience, and training. The study also took advantage of personal experience from the laboratory community, including interviews with knowledgeable people at the director, supervisor and non-supervisory S&E level, as well as personnel experts and people from headquarters. Finally, the study group reviewed other studies that had been conducted that covered details of scientist and engineer demand. These studies were done both within the Department of Defense and by other government and non-government bodies. Having assembled and analyzed a large amount of data, the study group then proceeded to identify the present and future needs of the scientist and engineer community within the Department of Defense laboratories and develop a set of recommendations.

STUDY OF SCIENTISTS AND ENGINEERS IN DOD LABORATORIES

- TERMS OF REFERENCE - DUSDR&E (R&AT) MEMO, 5 NOVEMBER 1981
  - DETERMINE STATUS OF S&E IN DOD LABS
    - WITH RESPECT TO NATIONAL SITUATION
    - IDENTIFY INDIVIDUAL LAB PECULIARITIES
  - IDENTIFY FUTURE NEEDS FOR S&E PERSONNEL
  - IDENTIFY AND EVALUATE RECRUITING AND RETENTION PROGRAMS
  - COMMENT ON NEED FOR DOD-WIDE S&E STUDY
- OBJECTIVE: VALIDATE REAL PROBLEMS
  MAKE APPROPRIATE RECOMMENDATIONS
- APPROACH:
  - GATHER DATA: DEFENSE MANPOWER DATA CENTER (DMDC), LAB QUESTIONNAIRES, BRIEFINGS, OTHER STUDIES
  - IDENTIFY NEEDS AND PROGRAMS
  - RECOMMEND POLICY CHANGES, NEED FOR BROADER STUDIES

CHART 5

This chart shows the study membership. The following pages contain a list of people who made notable contributions to the study, either in the form of briefings or other special assistance.

STUDY MEMBERSHIP

CHAIRMAN

DR. HERBERT RABIN, DEPUTY ASSISTANT SECRETARY OF THE NAVY (RESEARCH, APPLIED, AND SPACE TECHNOLOGY)

OFFICE OF THE SECRETARY OF DEFENSE

MS. JEANNE CARNEY, OFFICE OF THE DEPUTY UNDERSECRETARY OF DEFENSE (RESEARCH AND ADVANCED TECHNOLOGY)

MR. THOMAS HATHEWAY, OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE (MANPOWER, RESERVE AFFAIRS AND LOGISTICS)

ARMY

MR. ROBERT LANGWORTHY, MATERIEL DEVELOPMENT AND READINESS COMMAND

MR. DONALD E. COCHRAN, MATERIEL DEVELOPMENT AND READINESS COMMAND

NAVY

MR. STUART SIMON, NAVAL AIR DEVELOPMENT CENTER

MR. WALTER L. CLEARWATERS, NAVAL UNDERWATER SYSTEMS CENTER

AIR FORCE

COL. DAVID A. SMITH, OFFICE OF THE DEPUTY CHIEF OF STAFF (RESEARCH, DEVELOPMENT AND ACQUISITION)

MAJ. JOHN TUCKER, OFFICE OF DIRECTOR OF LABORATORIES, HEADQUARTERS AIR FORCE SYSTEMS COMMAND

CONTRACTOR SUPPORT BY THE ANALYTIC SCIENCES CORPORATION

DR. THOMAS F. WIENER
DR. ELEANOR G. FELDBAUM
DR. HARRY S. DAWSON, JR.

BRIEFINGS TO THE STUDY PANEL

- NATIONAL SCIENTIFIC AND ENGINEERING PERSONNEL SURVEY

  DR. ALAN FECHTER, DIVISION SCIENCE RESOURCE STUDIES, NATIONAL SCIENCE FOUNDATION, WASHINGTON, DC

- STUDIES OF SHORTAGES OF SCIENTISTS AND ENGINEERS

  DR. JACQUES S. GANSLER, VICE PRESIDENT, THE ANALYTIC SCIENCES CORPORATION, ARLINGTON, VA

- DOD RESERVE OFFICERS TRAINING PROGRAMS

  ALVIN TUCKER, DIRECTOR, TRAINING AND EDUCATION, OFFICE OF ASSISTANT SECRETARY OF DEFENSE (MANPOWER, RESERVE AFFAIRS AND LOGISTICS), PENTAGON

- INDUSTRY, GOVERNMENT AND ACADEMIC PROGRAMS TO MEET S&E NEEDS

  DR. JOHN W. GEILS, STAFF EXECUTIVE, FACULTY SHORTAGE PROBLEM, AMERICAN SOCIETY FOR ENGINEERING EDUCATION

- STUDY OF CIVILIAN ENGINEER RECRUITMENT, RETENTION, AND USE THROUGHOUT THE JOINT LOGISTICS COMMANDS

  RICHARD L. DIXON, CIVILIAN PERSONNEL DIVISION, AIR FORCE LOGISTICS COMMAND

- DOD CIVILIAN EDUCATION AND TRAINING PROGRAMS

  RICHARD J. SCHNURR, OFFICE OF ASSISTANT SECRETARY OF DEFENSE (MANPOWER, RESERVE AFFAIRS AND LOGISTICS), PENTAGON

- CO-OP PROGRAM AND OTHER CIVIL SERVICE AUTHORITIES

  THOMAS HATHEWAY, OFFICE OF ASSISTANT SECRETARY OF DEFENSE (MANPOWER, RESERVE AFFAIRS AND LOGISTICS), PENTAGON

- S&E PERSONNEL PERSPECTIVES FROM THREE SERVICE LABORATORY DIRECTORS

  DR. LOUIS CAMERON, DIRECTOR, ARMY NIGHT VISION AND ELECTRO-OPTICS LABORATORY, FORT BELVOIR, VA

  RONALD S. VAUGHN, TECHNICAL DIRECTOR, NAVAL SURFACE WEAPONS CENTER, DAHLGREN, VA

  COL. ROBERT RANKINE, COMMANDER, AIR FORCE WRIGHT AERONAUTICAL LABORATORIES, DAYTON, OH

- S&E PERSONNEL PERSPECTIVES FROM THREE SERVICE LABORATORY SUPERVISORS

  DR. AL HARVEY, CHEMISTRY DIVISION, NAVAL RESEARCH LABORATORY, WASHINGTON, DC

  MARTIN FALK, MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT COMMAND, FORT BELVOIR, VA

  JOHN SCOTT, AIR FORCE WEAPONS LABORATORY, KIRTLAND AIR FORCE BASE, NM

- S&E PERSONNEL PERSPECTIVES FROM THREE SERVICE LABORATORY NON-SUPERVISORY S&Es

  JOHN IMPAGLIAZZO, NAVAL UNDERSEA SYSTEMS CENTER, NEW LONDON, CT

  KEVIN SLIMAK, AIR FORCE ROCKET PROPULSION LABORATORY, EDWARDS AIR FORCE BASE, CA

  DENNIS COOK, ARMY HARRY DIAMOND LABORATORY, ADELPHI MD

- S&E PERSONNEL PERSPECTIVES FROM THREE SERVICE PERSONNEL SPECIALISTS

  FRANKLIN D. WALLACE, DIRECTOR, CIVILIAN PERSONNEL, OFFICE OF NAVAL RESEARCH AND NAVAL RESEARCH LABORATORY, WASHINGTON, DC

  WALTER M. STANISLAWSKI, PERSONNEL MANAGEMENT SPECIALIST, DIRECTORATE OF CIVILIAN PERSONNEL, AIR FORCE SYSTEMS COMMAND, ANDREWS AIR FORCE BASE, MD

  ROBERT W. BROOKS, CHIEF, RECRUITMENT AND PLACEMENT BRANCH, CIVILIAN PERSONNEL OFFICE, FORT BELVOIR, VA

- STUDY OF HIGH GRADES IN THE NAVY LABORATORIES

  LAURIE BROEDLING, NAVAL PERSONNEL RESEARCH AND DEVELOPMENT CENTER, SAN DIEGO, CA

- NAVY PERSONNEL DEMONSTRATION PROJECT

  WILLIAM P. RILEY, NAVAL OCEAN SYSTEMS CENTER, SAN DIEGO, CA

  BRUCE MACINTOSH, NAVAL WEAPONS CENTER, CHINA LAKE, CA

- SPECIAL ASSISTANCE TO THE STUDY PANEL

  JOYCE BRUNSELL, HEADQUARTERS, ARMY CORPS OF ENGINEERS, WASHINGTON, DC

  MICHAEL DOVE, DEFENSE MANPOWER DATA CENTER, MONTEREY, CA

  ALLEN HIMES, ASSOCIATE DIRECTOR, NAVY LABORATORIES, NAVAL MATERIAL COMMAND, WASHINGTON, DC

  MARK JANCZEWSKI, CAPTAIN, USAF, DEFENSE COMMUNICATIONS AGENCY, WASHINGTON, DC

  MARVIN MCGEE, CAPTAIN, USAF, DEFENSE COMMUNICATIONS AGENCY, WASHINGTON, DC

  SHIRLEE NEATHAMMER, CORPS OF ENGINEERS, CONSTRUCTION ENGINEERING RESEARCH LABORATORY, CHAMPAIGN, IL

  ALEX SINAIKO, DEFENSE MANPOWER DATA CENTER, ALEXANDRIA, VA

  ROBERT N. TAYLOR, OFFICE OF THE CHIEF OF NAVAL OPERATIONS, RESEARCH, DEVELOPMENT, TEST AND EVALUATION, PENTAGON

  DR. GERALD L. ATKINSON, THE ANALYTIC SCIENCES CORPORATION, ROSSLYN, VA

CHART 6

This caveat on the applicability of the study results is important. Most of the results which we cite are based on aggregation of laboratory data either across all DOD or across each service. We found a significant variation among the laboratories as we performed our analysis. Therefore, it is important to appreciate, in general, the results that are presented are overall or average results, and may not be directly applicable to a particular laboratory.

At this point in the briefing several other points should be made. The services use their laboratories differently. This gives rise to differences in interpretation of data reported. Two different data sources were used in developing personnel statistics. The trend data (1977-1981) were derived from the Defense 'anpower Data Center, while the 1981 information was derived from questonnaire responses. The two sources were cross-checked and found to agree within two percent. The "Technical Work Force" referred to in this study includes civilian and military scientists, engineers, and technicians. Reference to "Civilian" personnel in this study includes only full-time-permanent employees.

APPLICABILITY OF STUDY FINDINGS
TO EACH LAB
MAY VARY SIGNIFICANTLY

CHART 7

This section provides background information on the national shortage of scientists and engineers. Also included is information on prior studies and related ongoing governmental activities.

II. BACKGROUND

II. BACKGROUND

CHART 8

This study was engendered by a rising concern both inside and outside of government over current and projected shortages of scientists and engineers. Further there was particular concern within the Department of Defense that should the Defense budget rise as projected in the five-year defense plan, minor shortages present now could reach major proportions. While numerous studies have been done nationally to identify shortages, their findings and conclusions often conflict. Current studies generally perceive shortages throughout the country of computer professionals and some engineering specialists. On the other hand, there are other studies which indicate that there is no shortage now nor is it reasonable to expect a shortage in the future. These uncertainties come against a backdrop of a long decline in engineering baccalaureate degrees awarded followed by a rise in degrees at the baccalaureate level over the past seven years. However, the number of doctorates being awarded is still declining and almost half these degrees are being awarded to foreign students. Other problems being experienced on the supply side include faculty shortages, which can only be exacerbated by the decline in numbers of people awarded doctorate degrees who will teach at the college level. This is coupled with a decline in capital investment within the universities leading to obsolete lab equipment. On the brighter side, it appears that there are a variety of individual initiatives which have been instituted to address these problems.

NATIONAL SHORTAGE OF SCIENTISTS AND ENGINEERS

- RISING CONCERNS OVER SHORTAGE OF S&E THROUGHOUT ACADEMIA, INDUSTRY, AND GOVERNMENT
- CURRENT SHORTAGES OF COMPUTER PROFESSIONALS AND SOME ENGINEERING SPECIALTIES
- GENERAL CONCERNS OVER U.S. ABILITY TO PRODUCE ADEQUATE NUMBER OF QUALITY S&E PERSONNEL FOR REMAINDER OF THE '80S AND THE '90S
- UNCERTAINTY IN PROJECTIONS OF NEEDS (E.G., ECONOMIC FACTORS)
- SINCE 1975 STATISTICS SHOW INCREASES IN ENGINEERING GRADUATES AT THE BACCALAUREATE LEVEL, DECREASES IN PH.D.S (ESPECIALLY U.S. CITIZENS)
- UNIVERSITIES EXPERIENCING FACULTY SHORTAGES, STUDENT CAPACITY LIMITATIONS, LARGE FOREIGN ENROLLMENTS, OBSOLETE LAB EQUIPMENT
- VARIETY OF INITIATIVES TO REDRESS PROBLEMS UNDERWAY

CHART 9

Certain perceptions existed within DOD prior to the initiation of this study. It was clear that the Department of Defense laboratory system depends on the national supply of scientists and engineers. Some shortages were reported to exist within DOD laboratories. Furthermore, within the Department of Defense there is a unique environment for scientists and engineers, for example, the need to operate within the civil service system.

There was also existing a body of problems generally perceived by scientists and engineers themselves within the Department of Defense, including such things as inadequate salary, slow promotion, and inadequate personnel practices.

Finally, there was no comprehensive picture of the scientist and engineer status within the DOD laboratories.

PRE-STUDY PERCEPTIONS

- DOD S&E INTEGRALLY TIED TO NATIONAL SUPPLY
- SOME S&E SHORTAGES INDICATED WITHIN DOD LABS
- UNIQUE DOD S&E ENVIRONMENT (CIVIL SERVICE SYSTEM)
- CONCERNS EXPRESSED BY S&E
  (SALARY, PROMOTION, PERSONNEL PRACTICES)
- NO COMPREHENSIVE PICTURE OF S&E STATUS WITHIN DOD LABS

CHART 10

The perceptions were based, among other things, on a number of related studies having to do with scientists and engineers. The first of these was the Laboratory Management Task Force report of July 1980, which assessed the impact of management constraints. In the summer of 1981, the Defense Science Board conducted a study on the Department of Defense Technology Base which included some recommendations on the scientist and engineer population. Also, during the fall of 1981, the Joint Logistics Commanders (consisting of the commanders of the Army's Materiel Development and Readiness Command, the Navy Material Command, The Air Force Systems Command, and the Air Force Logistics Command) studied the recruitment, retention, and use of engineers.

In January of 1982, the Defense Science Board study on university responsiveness addressed the ability of universities to supply engineers and scientists among other concerns.

Finally, in February 1982, Dr. Robert Hermann's report for the Under Secretary of Defense for Research and Engineering presented his independent review of Department of Defense laboratories.

RECENT RELATED DOD STUDIES AND REPORTS

- Report of LMTF on Impact of Management Constraints on the DOD Laboratories - July 1980
- Defense Science Board Summer Study of DOD Technology Base - November 1981
- Joint Logistics Commanders Study of Engineers - October 1981
- Defense Science Board University Responsiveness Study - January 1982
- USDR&E Independent Review of DOD Laboratories (Hermann Report) - February 1982

CHART 11

These charts summarize the results of the studies shown previously. We considered these in the conduct of the current study.

PRIOR STUDIES

- Report of LMTF on Impact of Management Constraints on DOD Laboratories Recommended
  - Stabilize laboratory personnel ceilings
  - Repeal high grade ceilings and create Defense S&T Service
  - Adjust S&E pay scale to meet market competition
  - Remove restrictions on travel; reduce overlapping audits/inspections

- DSB Summer Study on DOD Tech Base Recommended
  - Increase 6.1 Basic Research performed by universities by 25% in 3 years
  - Implement Navy Personnel Demo Project in all DOD labs
  - Establish DOD Fellowships (100 per service)

- JLC Study on Engineers Recommended
  - Develop forecasting plan to identify engineering personnel needs
  - Establish special recruiting programs, including entry-level salary increases
  - Utilize special retention efforts, including career development programs and a uniform data base to monitor engineering personnel movement/losses
  - Improve utilization of engineering talent

PRIOR STUDIES

Continued

- DSB University Responsiveness Study Recommended
  - Award additional S&E graduate fellowships
  - Continue to support graduate student assistantships
  - Cooperate with other federal agencies on research funding, fellowships and other educational support
  - Promote closer ties between faculty and DOD laboratories; promote exchanges
  - Encourage publication of catalogue of fellowships, assistantships, scholarships offered by private and public sectors

- USDR&E Independent Review of DOD Laboratories (Hermann Report) Recommended
  - Upgrade Personnel Practices including:
    - RAISE PAY CAP
    - RELAX HI-GRADE CEILINGS
    - IMPLEMENT NAVY PERSONNEL DEMONSTRATION ACROSS THE BOARD
    - EXPAND STUDENT UTILIZATION PROGRAMS
    - ESTABLISH DEFENSE ENGINEERING TRAINING PROGRAM MODELED AFTER ROTC
    - ESTABLISH DIFFERENTIAL PAY SYSTEM FOR S&E'S
    - EXPAND CONTINUING EDUCATION PROGRAMS FOR S&E'S
    - EXPAND GRADUATE FELLOWSHIPS

CHART 13

While this study was being conducted, there were several significant activities in progress in various parts of the government. Within the Congress, a number of proposals were introduced which relate to shortages of scientists and engineers. At the same time, the White House Office of Science and Technology Policy began a study of the role of federal laboratories. Within the Department of Defense, the Navy developed a personnel demonstration project which revised the grade structure under which scientists and engineers operate. This project appears to be successful, and the Office of the Secretary of Defense is considering the development of a legislative proposal designed to implement the concepts of this project on a broader scale.

In January 1982 the Office of the Assistant Secretary of Defense for Manpower, Reserve Affairs and Logistics implemented the high grade relief based on legislation enacted in the fall of 1981.

Finally in the spring and summer of 1982, the Army Science Advisory Board initiated a study on S&E manpower.

SIGNIFICANT ONGOING GOVERNMENTAL ACTIVITIES

LEGISLATIVE ACTIONS:

- H.R. 5254 - "NATIONAL ENGINEERING AND SCIENCE MANPOWER ACT OF 1982"
- H.R. 5742 - "NATIONAL COMMISSION ON SCIENCE, ENGINEERING AND TECHNOLOGY EDUCATION"
- H.R. 5540 - "DEFENSE INDUSTRIAL BASE REVITALIZATION ACT"
- H.R. 6656 - "NATIONAL SCIENCE AND TECHNOLOGY REVITALIZATION ACT OF 1982"
- H.R. 6674 - "AMERICAN DEFENSE EDUCATION ACT"
- H.R. 3380 - "ARMED FORCES PAY ACT OF 1981"
- S. 2421 - "NATIONAL TECHNICAL, ENGINEERING, AND SCIENTIFIC MANPOWER AND EDUCATION ACT OF 1982"
- S. 2663 - "AMERICAN DEFENSE EDUCATION ACT"
- H. CON. RES. 204 - "NATIONAL SCIENCE CENTER FOR COMMUNICATIONS AND ELECTRONICS"

EXECUTIVE BRANCH ACTIONS:

- OFFICE OF SCIENCE AND TECHNOLOGY POLICY STUDY ON ROLE OF FEDERAL LABORATORIES

SIGNIFICANT ONGOING GOVERNMENTAL ACTIVITIES (CONT.)

DOD ACTIONS:

- NAVY PERSONNEL DEMONSTRATION PROJECT UNDER CSRA TITLE VI
- OASD (MRA&L) HIGH GRADE RELIEF - JANUARY '82
- ARMY SCIENCE ADVISORY BOARD 1982 SUMMER STUDY ON S&E MANPOWER
- OSD CONSIDERATION OF DRAFT LEGISLATION TO IMPLEMENT CONCEPTS OF NAVY PERSONNEL DEMONSTRATION PROJECT
- DOD, DOL, AND FEMA 1982 SUMMER MOBILIZATION EXERCISE

CHARTS 15 & 16

The following charts give some details of the legislative actions shown on a preceding chart. They are all intended to develop a national policy on scientists and engineers, and some propose programs to increase their supply.

LEGISLATIVE ACTIONS

H.R. 5254 - ESTABLISHES A NATIONAL COORDINATING COUNCIL ON ENGINEERING AND SCIENTIFIC MANPOWER WITHIN THE NATIONAL SCIENCE FOUNDATION.

ESTABLISHES A SPECIAL ENGINEERING AND SCIENCE MANPOWER FUND FOR RESEARCH FELLOWSHIPS, CAPITAL EQUIPMENT, SALARIES, AND INSTRUMENTATION.

H.R. 5742 - ESTABLISHES A COMMISSION TO EXAMINE AND DEFINE THE SCOPE OF SCIENCE, ENGINEERING, AND TECHNOLOGY EDUCATION IN THE UNITED STATES.

EVALUATES THE IMPACT ON DEFENSE INDUSTRY RESEARCH AND ACADEMIA AND FORMULATES REMEDIAL ACTIONS.

H.R. 5540 - PROVIDES GRANTS TO STATE BOARDS OF VOCATIONAL EDUCATION THAT PLAN FIVE YEAR PROGRAMS FOR TRAINING, UPGRADING SKILLS, AND RETRAINING IN DEPRESSED INDUSTRIES.

PROPOSES A GRANT PROGRAM TO ASSIST COLLEGES, UNIVERSITIES, AND OTHER INSTITUTIONS OF HIGHER EDUCATION IN OBTAINING AND INSTALLING MODERN EQUIPMENT WHICH SHALL BE USED TO TRAIN PROFESSIONAL, SCIENTIFIC, AND TECHNICAL PERSONNEL.

H.R. 6656 - ESTABLISHES A PROGRAM OF PRESIDENTIAL TEACHING AND RESEARCH FELLOWSHIPS IN MATHEMATICS AND SCIENCE, AND A PRESIDENTIAL PRECOLLEGE SCIENCE AND MATHEMATICS IN-SERVICE TEACHING PROGRAM.

LEGISLATIVE ACTIONS (CONT.)

H.R. 6674 - AUTHORIZES A NATIONAL PROGRAM OF INCENTIVES WHICH WOULD ASSIST LOCAL EDUCATIONAL AGENCIES IN IMPROVING THE QUALITY OF INSTRUCTION IN THE FIELDS OF MATHEMATICS, THE SCIENCES, COMMUNICATION SKILLS, FOREIGN LANGUAGES, AND TECHNOLOGY IN THE SCHOOLS OF THE U.S.

H.R. 3380 - DESIGNATES ENGINEERING AND SCIENTIFIC SKILLS AS CRITICAL AND PROVIDES SPECIAL PAY FOR ENGINEERING AND SCIENTIFIC CAREERS.

S. 2421 - ESTABLISHES THE NATIONAL COORDINATING COUNCIL ON TECHNICAL ENGINEERING AND SCIENTIFIC MANPOWER AND EDUCATION.

ESTABLISHES A FUND TO FURTHER THE DEVELOPMENT OF ADEQUATE AND NECESSARY RESOURCES IN THE AREAS OF SCIENCE AND ENGINEERING.

S. 2663 - PROVIDES GRANTS TO STATE BOARDS OF VOCATIONAL EDUCATION THAT PLAN FIVE-YEAR PROGRAMS FOR TRAINING, UPGRADING SKILLS, AND RETRAINING IN DEPRESSED INDUSTRIES.

PROPOSES A GRANT PROGRAM TO ASSIST COLLEGES, UNIVERSITIES, AND OTHER INSTITUTIONS OF HIGHER EDUCATION IN OBTAINING AND INSTALLING MODERN EQUIPMENT WHICH SHALL BE USED TO TRAIN PROFESSIONAL, SCIENTIFIC AND TECHNICAL PERSONNEL.

H. CON. RES. 204 - PROPOSES THE ESTABLISHMENT OF A NATIONAL SCIENCE CENTER FOR COMMUNICATIONS AND ELECTRONICS TO ENCOURAGE EDUCATIONAL PROGRAMS IN SCIENCE AND TECHNOLOGY.

<u>CHART 17</u>

This section presents various data describing the laboratories, their S&E work force, the type of work accomplished, as well as a comparision with the national S&E work force. This section is concluded with a summary chart of the material included. Each of the subsequent sections of the report follows the same format with a summary closing chart.

III. DOD LABS
AND
S&E WORK FORCE

III

III. DOD LABS AND S&E WORK FORCE

CHART 18

Thirty-nine Army laboratories responded to the questionnaire, as did 21 Navy, and 11 Air Force, for a total of 71. Their total workforce is 58,290 people, of which the smallest group is the Air Force and the largest group is the Navy. Of the total workforce, 52 percent is technical.

The total budget for all Department of Defense laboratories is almost six billion dollars -- with about 20 percent managed by the Air Force and about 40 percent each managed by the Army and Navy. Their locations and size are also shown.

Twenty-five laboratories deal with medical and human resource matters. These are in general much smaller than the other laboratories, with none of them having more than 500 civilian scientists and engineers, and only six of them having more than 100. In the non-medical laboratories, the Army and Air Force tend to be smaller than the Navy laboratories. The next chart shows the use of military S&E at medical and human resources labs.

We have also included a complete list of the laboratories studied, as well as their locations and S&E population.

DOD LABORATORIES
(END FY 81)

	ARMY	NAVY	AIR FORCE	TOTAL
NUMBER OF LABORATORIES	39	21	11	71
TOTAL WORK FORCE	24,882	25,583	7,825	58,290
TOTAL TECHNICAL WORK FORCE	10,735	13,871	5,576	30,182
TOTAL BUDGET ($B)	2.4	2.2	1.2	5.8
LOCATION:				
NORTHEAST (MA, NH, RI, NY)	5	3	2	10
DC METROPOLITAN AREA	8	4	0	12
MIDATLANTIC (NJ, PA, MD, VA)	16	2	0	18
SOUTH (FL, AL, MS, LA)	4	4	2	10
MIDWEST (OH, IL, MI, CO)	3	1	3	7
WEST (TX, NM, CA)	4	7	4	14
SIZE (TOTAL/MEDICAL & HUMAN RESOURCES)				
100 OR FEWER CIVILIAN S&E	15/10	9/8	3/1	27/19
101 - 499 CIVILIAN S&E	21/3	5/1	6/2	32/6
500 - 999 CIVILIAN S&E	2/0	0/0	1/0	3/0
1,000 OR MORE CIVILIAN S&E	1/0	7/0	1/0	9/0
TOTAL	39/13	21/9	11/3	71/25

CHART 19

In the Army and Navy, the majority of the military scientists and engineers are in the medical and human resources laboratories.

MILITARY S&E

(SEPTEMBER 30,1981)

	ARMY	NAVY	AIR FORCE	TOTAL
TOTAL MILITARY S&E AT ALL LABS	429	214	1,278	1,923
MILITARY S&E AT MEDICAL AND HUMAN RESOURCES LABS	300	109	226	635
PERCENT OF TOTAL MILITARY S&E AT MEDICAL AND HUMAN RESOURCES LABS	70	51	18	33

DOD LABS INCLUDED IN STUDY

(30 SEPTEMBER 1981 S&E POPULATION)

ARMY	CIVILIAN S&E	MILITARY S&E
Large Cal. Weapon Systems Lab, Dover, NJ	1,042	8
Army Missile Laboratory, Redstone Arsenal, AL	640	27
Engineer Waterways Experiment Station, Vicksburg, MS	507	12
Chemical Systems Lab, Aberdeen Proving Ground, MD	434	22
Mobility Equipment R&D Command, Ft. Belvoir, VA	423	10
Fire Control & Small Cal. Weapon Systems Lab, Dover, NJ	419	5
Ballistics Research Lab, Aberdeen Proving Ground, MD	409	12
Harry Diamond Lab, Adelphi, MD	331	3
Natick R&D Labs, Natick, MA	314	0
Research & Technology Labs, Moffett Field, CA	249	0
Night Vision & Electro-Optics Lab, Ft. Belvoir, VA	204	2
Electronics Warfare Lab, Ft. Monmouth, NJ	203	3
Army Research Institute, Alexandria, VA	200	1
Materials & Mechanics Research Center, Watertown, MA	198	5
Electronics Technology & Devices Lab, Ft. Monmouth, NJ	158	0
Engineer Topographic Labs, Ft. Belvoir, VA	158	5
Communications Systems Center, Ft. Monmouth, NJ	153	0
Avionics R&D Activity, Ft. Monmouth, NJ	152	3
Tank Automotive Systems Lab, Warren, MI	150	10

DOD LABS INCLUDED IN STUDY, Cont.

ARMY (CONT.)	CIVILIAN S&E	MILITARY S&E
WALTER REED ARMY INST. OF RESEARCH, WASHINGTON, DC	148	145
BENET WEAPONS LAB, WATERVLIET, NY	129	0
CONSTRUCTION ENGINEERING RESEARCH LAB, CHAMPAIGN, IL	112	9
COLD REGIONS R&E LAB, HANOVER, NH	110	3
HUMAN ENGINEERING LAB, ABERDEEN PROVING GROUND, MD	101	6
ATMOSPHERIC SCIENCES LAB, WHITE SANDS MISSILE RANGE, NM	98	1
COMBAT SURVEILLANCE & TARGET ACQUISITION LAB, FT. MONMOUTH, NJ	93	7
COMMUNICATIONS-ELECTRONICS R&D CENTER, FT. MONMOUTH, NJ	84	1
MEDICAL RESEARCH INST. OF INFECTIOUS DISEASES, FREDERICK, MD	59	53
SIGNALS WARFARE LAB, WARRENTON, VA	59	14
TANK AUTOMOTIVE CONCEPTS LAB, WARREN, MI	48	2
MEDICAL RESEARCH INST. OF CHEM. DEFENSE, ABERDEEN PROVING GROUND, MD	41	29
CENTER FOR SYSTEMS ENGINEERING INTEGRATION, FT. MONMOUTH, NJ	39	15
MEDICAL R&D COMMAND*	37	23
MEDICAL BIOENGINEERING R&D LAB, FREDERICK, MD	36	12
RESEARCH INST. OF ENVIRONMENTAL MEDICINE, NATICK, MA	36	14
LETTERMAN ARMY INST. OF RESEARCH, PRESIDIO OF SAN FRANCISCO, CA	31	36

*NOT INCLUDED IN QUESTIONNAIRE DATA BASE

DOD LABS INCLUDED IN STUDY, Cont.

ARMY (CONT.)	CIVILIAN S&E	MILITARY S&E
AEROMEDICAL RESEARCH LAB, FT. RUCKER, AL	19	24
INST. OF SURGICAL RESEARCH, FT. SAM HOUSTON, TX	15	19
INST. OF DENTAL RESEARCH, WASHINGTON, DC	4	19
OVERSEAS OPERATING BRANCH, WASHINGTON, DC	2	27

DOD LABS INCLUDED IN STUDY, Cont.

NAVY	CIVILIAN S&E	MILITARY S&E
Naval Surface Weapons Center, Dahlgren, VA	2,027	27
Naval Underwater Systems Center, Newport, RI	1,393	8
Naval Research Lab, Washington, DC	1,327	3
Naval Weapons Center, China Lake, CA	1,290	7
Naval Ocean Systems Center, San Diego, CA	1,280	31
David W. Taylor Naval Ship R&D Center, Bethesda, MD	1,148	15
Naval Air Development Center, Warminster, PA	1,129	28
Naval Coastal Systems Center, Panama City, FL	286	0
Naval Civil Engineering Lab, Port Hueneme, CA	168	7
Naval Air Propulsion Center, Trenton, NJ	157	6
Navy Personnel R&D Center, San Diego, CA	155	7
Naval Ocean R&D Activity, Bay St. Louis, MS	134	0
Naval Medical Research Institute, Bethesda, MD	64	65
Navy Clothing & Textile Research Fac., Natick, MA	37	0
Naval Submarine Medical Research Lab, New London, CT	25	13
Naval Biodynamics Lab, New Orleans, LA	21	8
Naval Aero. Medical Research Lab, Pensacola, FL	20	17
Naval Environmental Predict. Research Fac., Monterey, CA	20	0
Naval Health Research Center, San Diego, CA	19	13
Naval Dental Research Inst., Great Lakes, IL	4	12

DOD LABS INCLUDED IN STUDY, Cont.

NAVY (CONT.)	CIVILIAN S&E	MILITARY S&E
NAVAL MEDICAL RESEARCH UNIT #2, MANILLA, PHILLIPPINES AND DJARKARTA, INDONESIA*	2	4
NAVAL MEDICAL RESEARCH UNIT #3, CAIRO, EGYPT*	1	3
NAVAL ARCTIC RESEARCH LAB, PT. BARROW, AK*	0	1
NAVAL BIOSCIENCES LAB, OAKLAND, CA	0	2
NAVAL MEDICAL RESEARCH INST. TOXICOLOGY DET., DAYTON, OH*	0	4

*NOT INCLUDED IN QUESTIONNAIRE DATA BASE

DOD LABS INCLUDED IN STUDY, Cont.

AIR FORCE	CIVILIAN S&E	MILITARY S&E
AF Wright Aeronautical Lab, Wright-Patterson AFB, OH	1,361	315
Rome Air Development Center, Griffiss AFB, NY	610	102
AF Geophysics Lab, Hanscom AFB, MA	284	26
AF Weapons Lab, Kirtland AFB, NM	220	319
AF Armament Lab, Eglin AFB, FL	198	97
AF Rocket Propulsion Lab, Edwards AFB, CA	109	65
USAF School of Aerospace Medicine, Brooks AFB, TX	107	119
AF Human Resources Lab, Brooks AFB, TX	103	35
AF Aerospace Medical Research Lab, Wright-Patterson AFB, OH	84	42
Engineering Services Lab, Tyndall AFB, FL	13	48
Frank J. Seiler Pesearch Lab, USAF Academy, CO	5	15

CHART 20

We have separated the work of technical personnel into tech base (i.e., 6.1, 6.2, and 6.3A as defined in the DOD Budget guidance), system development (which is 6.3B and 6.4), test and evaluation, and product support. There is a residual category indicated for other activities.

In each service tech base work occupies the largest portion of the manpower. The Air Force has almost three-fourths of its manpower assigned to tech base activities. The Navy has nominally one-third of its technical manpower devoted to system development, significantly larger than either the Army or Air Force.

TECHNICAL MANPOWER ALLOCATION BY TYPE OF WORK

(PERCENT)

	ARMY	NAVY	AIR FORCE	TOTAL
TECH BASE	47	32	72	45
SYSTEM DEVELOPMENT	18	29	15	22
TEST & EVALUATION	5	7	1	5
PRODUCT SUPPORT	15	20	3	15
OTHER	15	12	9	13
	100	100	100	100

CHART 21

We have also separated the manpower allocation into type of job that is done. For example, benchwork or "hands on" scientific work of the sort one generally associates with laboratory activity, line management, contract monitoring or management. Here again, the distinction between the Air Force and the Army and Navy laboratories is evident. Over half of Army and Navy lab technical manpower is applied to hands-on work. The Air Force uses about one-third of its S&E manpower for contract management.

TECHNICAL MANPOWER ALLOCATION BY TYPE OF JOB

(PERCENT)

	ARMY	NAVY	AIR FORCE	TOTAL
BENCH WORK/"HANDS ON"	54	55	36	51
LINE MANAGEMENT	13	11	10	12
CONTRACT MONITORING	17	21	33	22
STAFF ADMINISTRATION	4	3	7	4
PLANNING	5	2	5	4
DIRECTOR/ADVISORY	3	2	2	2
OTHER	4	6	7	5
	100	100	100	100

CHART 22

The percentage of the laboratory budget that is contracted out is shown here. These statistics do not include military salaries or laboratory efforts in support of sponsor contracts in which the funding does not flow to the laboratory. Again, the Air Force uses almost three-fourths of its funding for contract work. This chart and the preceding two point out differences between the Air Force and the other two services with regard to the use of their laboratories.

WORK CONTRACTED OUT BY DOD LABS

(PERCENT OF FY 81 FUNDS)

ARMY	48.7
NAVY	42.5
AIR FORCE	73.2
TOTAL	51.5

CHART 23

The DOD laboratory scientist and engineer population is significantly different from the national scientist and engineer population as found by the National Science Foundation in as yet unpublished survey data. In the DOD labs, 62 percent of the S&E are engineers as opposed to 48 percent over the nation. This is consistent with Department of Defense emphasis on weapon system development. Within the DOD laboratories there is a significantly smaller percentage of women than in the national survey, while there is a somewhat higher percentage of minority personnel. Advanced degrees of S&E's occur in a somewhat greater proportion in Department of Defense laboratories. The average age in DOD labs is almost five years greater than the national survey.

COMPARISON OF DOD LAB AND NATIONAL (NSF) DATA FOR CIVILIAN S&E

(1980 DATA IN PERCENT EXCEPT WHERE NOTED)

	DOD LABS	NATIONAL
PERCENT ENGINEERS	62	48
PERCENT SCIENTISTS	38	52
PERCENT WOMEN	5.2	12.7
PERCENT MINORITY	6.9	4.9
HIGHEST DEGREE		
DOCTOR	14	11
MASTER	26	24
BACHELOR	57	63
LESS THAN BACHELOR	3	2
AVERAGE AGE	42.2 YRS.	37.6 YRS.

CHART 24

This chart shows the technical work force of the DOD laboratories and the larger community of which it is a part. The DOD civilian and military S&E totals shown (78,000 and 27,000, respectively) exclude medical doctors and dentists, and the military S&E total represents only military S&E assigned to S&E billets. Also shown are total laboratory work force and technical work force by service and by type of employee. The 105,000 DOD S&E represent approximately 3.5 percent of the national S&E work force. DOD lab S&E are about 23 percent of the DOD S&E and 0.8 percent of the national S&E work force.

TOTAL (CIVILIAN AND MILITARY) POPULATION

(SEPTEMBER 30, 1981)

DoD Civilian S&E	78 thousand
DoD Military S&E	27 thousand
National S&E	2.9 million

	Army	Navy	Air Force	Total
Total DoD Laboratory	24,882	25,583	7,825	58,290
Total Laboratory Technical	10,735	13,871	5,576	30,182
Civilian Scientists	3,127	4,099	1,044	8,270
Military Scientists	314	145	456	915
Total Scientists	3,441	4,244	1,500	9,185
Civilian Engineers	4,837	6,654	2,006	13,497
Military Engineers	115	69	822	1,006
Total Engineers	4,952	6,723	2,828	14,503
Civilian Technicians	2,342	2,904	495	5,741
Military Technicians	*	*	753	753
Total Technicians	2,342	2,904	1,248	6,494

*Negligible

CHART 25

As shown here, only in Air Force laboratories is the military a major component of the S&E work force.

TOTAL (CIVILIAN AND MILITARY) POPULATION, (Cont.)

(SEPTEMBER 30, 1981)

	ARMY	NAVY	AIR FORCE	TOTAL
CIVILIAN S&E	7,964	10,753	3,050	21,767
MILITARY S&E	429	214	1,278	1,921
TOTAL S&E	8,393	10,967	4,328	23,688
MILITARY S&E AS PERCENT TOTAL S&E	5	2	30	8

CHART 26

This chart shows civilian employment in DoD laboratories for 1977 through 1981. The left side depicts total total civilian laboratory employment, while the right side shows the civilian S&E population. Breakouts are provided for each of the military departments. Both the total and S&E population have dropped over the five year period by about two percent. The services differ slightly from one another with the Navy showing a decline while the Army and Air Force remained essentially flat. The Navy's rate of decline in total laboratory personnel has varied between one and two percent per year over the last five years, continuing a loss over many years. Over the same period, however, the Navy's S&E work force has been maintained at essentially a constant level.

CIVILIAN EMPLOYMENT IN DOD LABS
30 SEPTEMBER

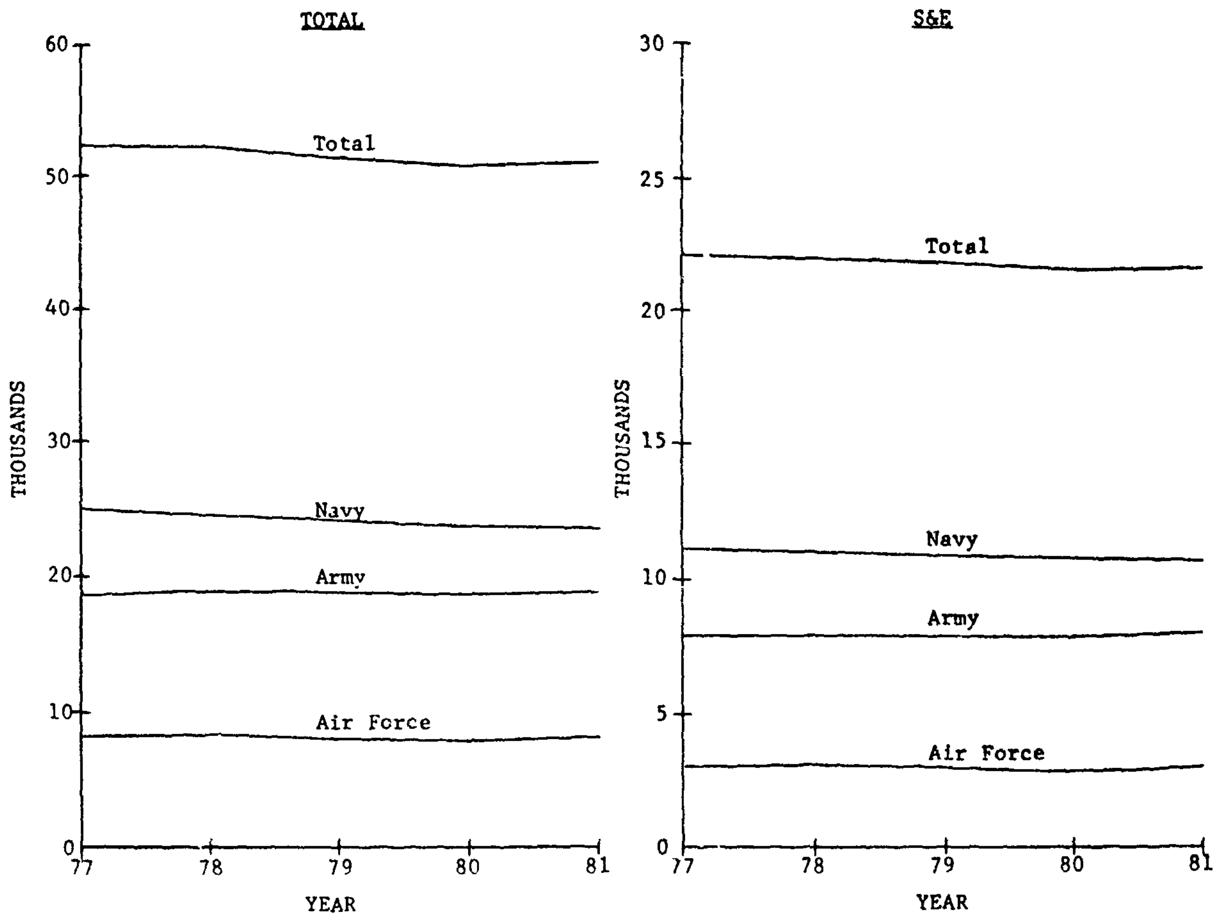


CHART 27

Here the average age of the scientists and engineers and the technicians in the DOD laboratories is shown. The average S&E and technician ages are about 42 years and 45 years, respectively. You will recall that the average age of the scientists and engineers is about five years greater than the average age of the scientists and engineers in the national population.

CIVILIAN WORK FORCE AGE IN DOD LABS

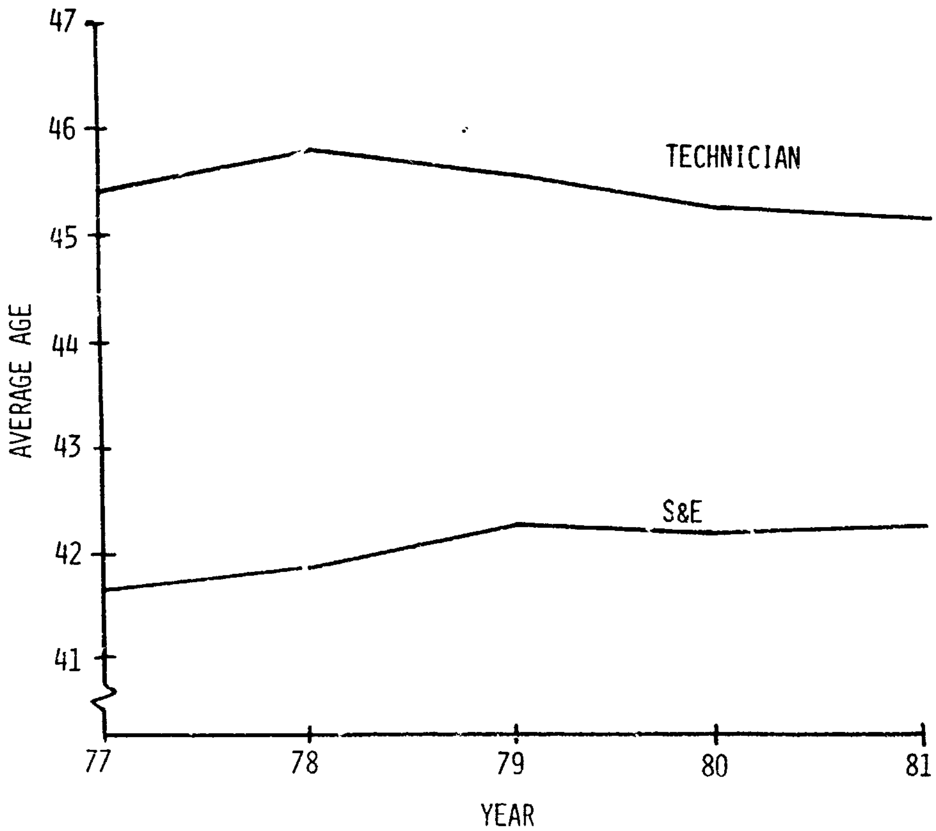


CHART 28

This chart summarizes the comments of the laboratory directors in responding to the study questionnaire on the impact of civilian personnel ceilings. The thrust of these comments is that limitations on total personnel resources adversely impact on the performance of the laboratories.

IMPACTS OF CIVILIAN PERSONNEL CEILINGS

LAB DIRECTORS REPORT:

- REDUCED ABILITY TO MEET MISSION REQUIREMENT
  - CRITICAL PROBLEMS UNADDRESSED
  - TECHNICAL RISK INCREASED
- DELETION OF SPECIFIC TECHNOLOGIES WHICH SHOULD BE ADDRESSED
- INCREASED CONTRACTING OUT
  - REDUCES AMOUNT OF IN-HOUSE WORK
  - LIMITS ABILITY TO MAINTAIN "SMART BUYER" CAPABILITY
- LIMITED ABILITY TO RESPOND TO UNPROGRAMMED REQUIREMENTS
- INCREASED USE OF TEMPORARY PERSONNEL

CHART 29

This section has shown the characteristics of the DOD laboratories and its technical work force. There are considerable differences between the labs of various services, including numbers of laboratories, types of personnel, and variety of work. The Navy has 46 percent of the total scientists and engineers. The military technical work force represents eight percent of the total S&E population. Air Force officers comprise about two-thirds of the military S&E and about 30 percent of the Air Force S&E work force. The Air Force, devoting 72 percent of its manpower to tech base work, has a significantly higher proportion than the other services. It also has the highest percentage of outside contracting at 73 percent.

The Department of Defense scientists and engineers are different in composition from the national scientists and engineers, having a smaller percentage of women and being about five years older. The change in number of laboratory personnel over the period of 1977-1981 shows the Army's rising slightly, the Air Force's dropping very little, and the Navy's dropping about six percent. The Department of Defense laboratory scientists and engineers are a small percentage of the national S&E work force, being less than one percent. This population, however, is a significant portion (almost one quarter) of the Department of Defense S&E work force. Finally, the laboratories report significant adverse impacts caused by total personnel ceiling.

SUMMARY: DOD LABS AND S&E WORK FORCE

- CONSIDERABLE VARIATION AMONG SERVICE LABS
  - WORK FORCE AND FUNDING
  - NUMBER OF LABS (ARMY 39, NAVY 21, AIR FORCE 11)
  - NAVY HAS 46% OF THE TOTAL S&E
  - AIR FORCE HAS 67% OF THE MILITARY S&E
  - AIR FORCE PREDOMINANTLY TECH BASE (72% MANPOWER), HIGHEST CONTRACT RATIO (73% FUNDING)
- DOD S&E DIFFER FROM NATIONAL S&E (PERCENT WOMEN, AVERAGE AGE)
- TOTAL WORK FORCE AND S&E POPULATION DECLINED ABOUT 2% FROM 1977 TO 1981
  - ARMY UP SLIGHTLY, AIR FORCE DOWN SLIGHTLY, NAVY DOWN ABOUT 6%
- LAB S&E ARE 23% OF DOD S&E, 0.8% OF NATIONAL S&E
- DIRECTORS REPORT SIGNIFICANT ADVERSE IMPACT OF TOTAL PERSONNEL CEILING

CHART 30

Data describing the education and salary of the DOD laboratory S&E work force are presented in this section, and compared to national data. Also included is an assessment of grade distribution within the laboratory S&E population.

IV. EDUCATION & SALARY

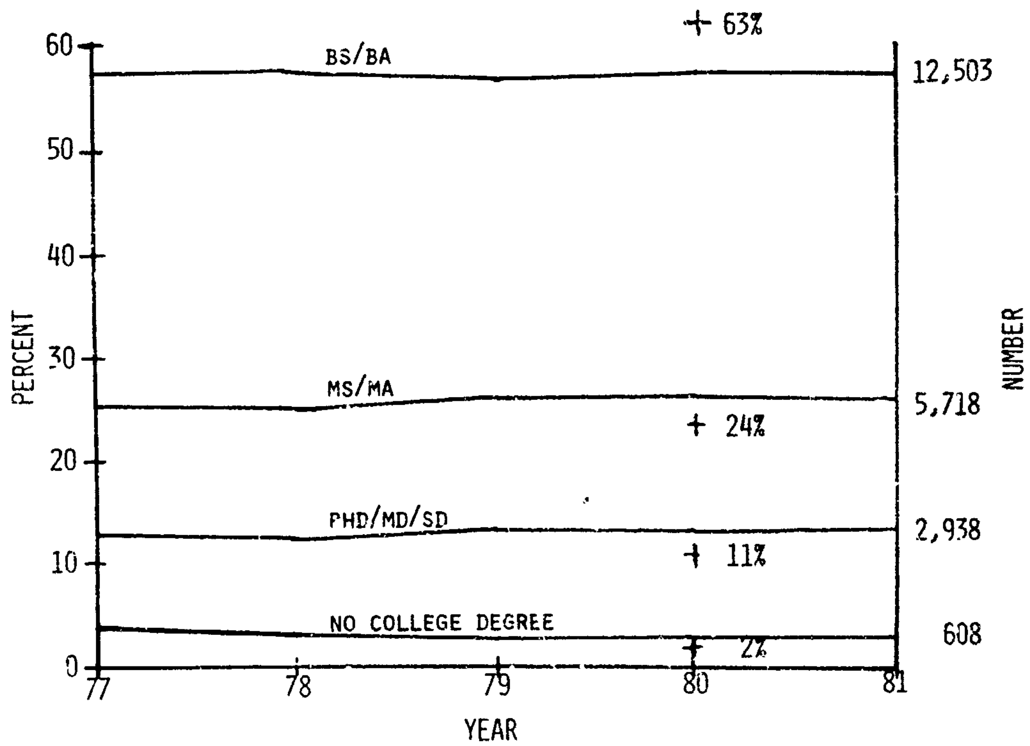
IV

IV. EDUCATION & SALARY

CHART 31

The distribution of degrees among the laboratory S&E workforce has remained essentially constant over the five-year period with bachelors at about 57 percent, masters at about 26 percent, and doctorates at about 13 percent. This is a higher proportion of advanced degrees than in the national S&E work force also shown on the chart.

DOD LAB CIVILIAN S&E EDUCATION



+ TOTAL NATIONAL S&F DEGREE DISTRIBUTION FOR 1980

CHART 32

This chart displays data on the number of advanced engineering degrees awarded in the United States. The number of masters degrees awarded has increased 7 percent in the ten years 1968-69 through 1978-79 while the number of doctors degrees has decreased 17 percent in the same period. In addition, the number of degrees awarded to foreign students doubled in the five years from 1968-69 through 1973-74. The masters degrees awarded to U.S. citizens dropped by nine percent over the ten years shown, while the number of doctorates awarded to U.S. citizens dropped by over one-third. Not only does this limit the technical expertise in the work force, it has serious consequences for engineering faculty in institutions of higher learning. Since employment within the DOD laboratories is limited to U.S. citizens, a declining base of advanced degree recipients has been available for lab recruitment. At least during the period 1977-81 the DOD labs, however, have remained steady as shown in the previous chart. This result has been noted to occur with an increasing average age of lab S&E holding doctorates. There has been a decreasing number of doctorates below age 35 and an increasing number above.

ADVANCED ENGINEERING DEGREES CONFERRED IN U.S.

	Degrees Awarded			Degrees Awarded to Foreigners			Percent of Degrees Awarded to Foreigners		
	1968/9	1973/4	1978/9	1968/9	1973/4	1978/9	1968/9	1973/4	1978/9
Masters	14,980	15,885	16,036	1,784	3,099	4,066	12	20	25
Doctors	3,387	3,362	2,815	410	1,014	929	12	30	33

- Number of Advanced Degrees awarded to foreigners almost doubled between 1968/69 and 1973/74

- Number of Advanced Degrees awarded to U.S. citizens has dropped significantly
  - Masters decreased by 9% in ten years
  - Doctors decreased by 37% in ten years

CHART 33

This chart shows the grade distribution at the end of fiscal year 1981 for the scientists and engineers in DOD laboratories. There are comparatively few GS-5 and GS-7, nominally three percent of the S&E work force. The remainder of the S&E work force is approximately evenly divided between GS-9 to GS-12 and GS-13 to GS-15. The percentages by services are shown. The Air Force has a different composition, because Air Force officers are a significant portion of the S&E work force. In fact, most of these officers are company grade officers. If the Air Force S&E work force of almost 4400 is considered with company grade officers being included in the GS-9 to 12 group, and field grade officers in the GS-13 to GS-15 group, the percentages would be more in line with those of the Army.

S&E GRADE DISTRIBUTION

(SEPTEMBER 30, 1981)

CIVILIAN	ARMY	NAVY	AIR FORCE	TOTAL
GS 5- 7	282	347	104	733
9-12	3,743	5,564	1,040	10,347
13-15	3,878	4,733	1,881	10,492
SES/16-18	61	109	25	195
TOTAL	7,964	10,753	3,050	21,767
% 9-12	47.0	51.7	34.1	47.5
% 13-15	48.7	44.0	61.6	48.2
MILITARY				
WO/O-1/2	43	17	441	501
O-3/4/5	327	178	753	1,258
O-6	59	19	84	162
TOTAL	429	214	1,278	1,921

S&E GRADE DISTRIBUTION

(SEPTEMBER 30, 1981)

CIVILIAN	ARMY	NAVY	AIR FORCE	TOTAL
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WO/0-1/2	43	17	441	501
0-3/4/5	327	178	753	1,258
0-6	59	19	84	162
TOTAL	429	214	1,278	1,921

CHART 34

This chart shows the civilian grade distribution graphically over the period 1977-1981. Note that the GS-9 to GS-12 and GS-13 to GS-15 groups have remained reasonably constant, while GS-5 to GS-7 group has been increasing.

S&E CIVILIAN GRADE DISTRIBUTION
(30 SEPTEMBER)

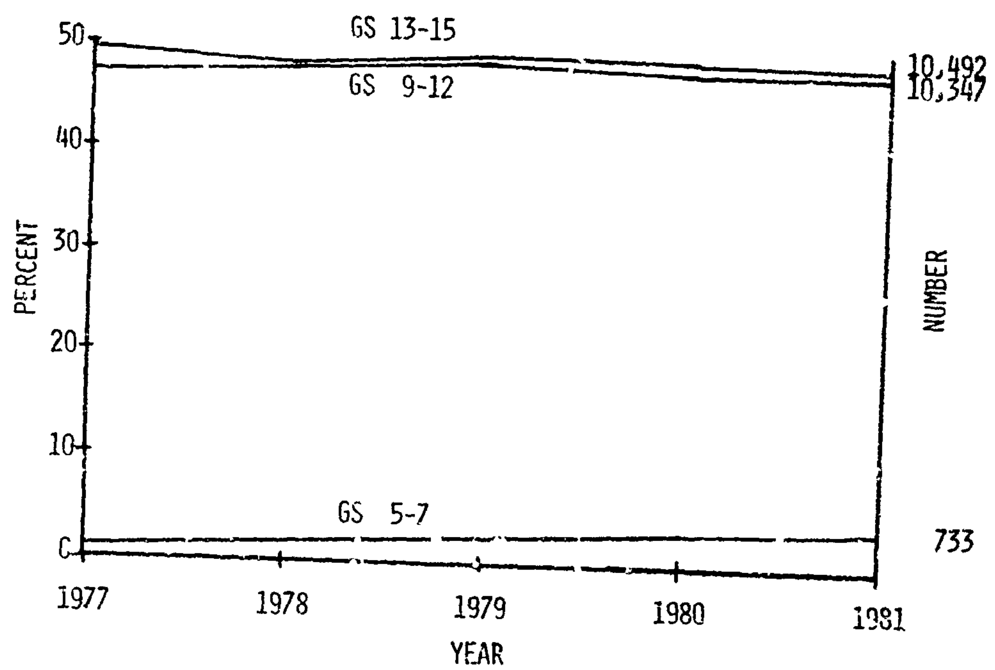
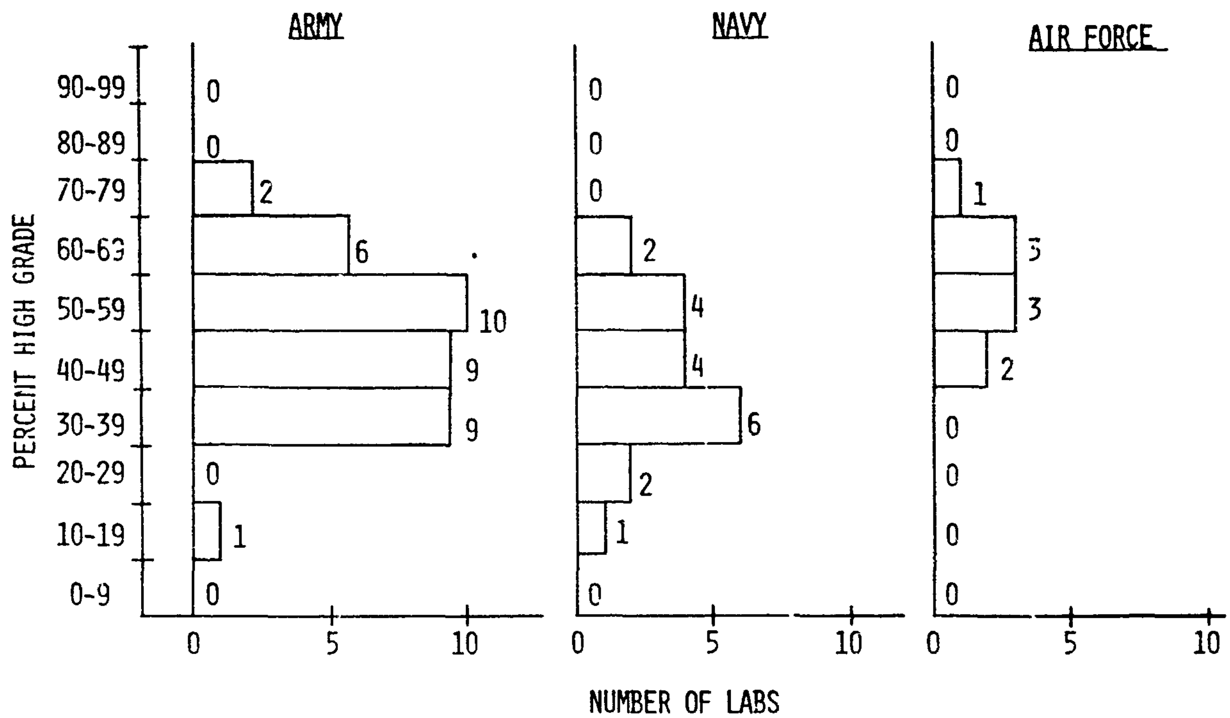


CHART 35

These histograms show the GS-13 to GS-15 S&E distribution in the DOD laboratories. Laboratories with fewer than 15 S&E are not included. We see a considerable range in high grade distribution across the laboratories.

HIGH GRADE (GS 13-15) S&E DISTRIBUTION BY NUMBER OF LABS*



*EXCLUDES LABS WITH FEWER THAN 15 CIVILIAN S&E

PERCENT HIGH GRADE S&E (GS 13-15) IN DOD LABS
(SEPTEMBER 30, 1981)

ARMY	CIVILIAN S&E	PERCENT HIGH GRADE
OVERSEAS OPERATIONS BRANCH, WASHINGTON, DC	2	100
CENTER FOR SYSTEMS ENGINEERING & INTEGRATION, FT. MONMOUTH, NJ	39	72
NIGHT VISION & ELECTRO-OPTICS LAB, FT. BELVOIR, VA	204	71
ELECTRONICS TECHNOLOGY & DEVICES LAB, FT. MONMOUTH, NJ	158	66
TANK AUTOMOTIVE CONCEPTS LAB, WARREN, MI	48	65
HARRY DIAMOND LAB, ADELPHI, MD	331	63
ENGINEER TOPOGRAPHIC LABS, FT. BELVOIR, VA	158	61
SIGNALS WARFARE LAB, WARRENTON, VA	59	61
AVIONICS R&D ACTIVITY, FT. MONMOUTH, NJ	152	60
TANK AUTOMOTIVE SYSTEMS LAB, WARREN, MI	150	59
MOBILITY EQUIPMENT R&D COMMAND, FT. BELVOIR, VA	423	58
COMBAT SURVEILLANCE & TARGET ACQUISITION LAB, FT., MONMOUTH, NJ	93	56
ARMY MISSILE LABORATORY, REDSTONE ARSENAL, AL	640	55
MATERIALS & MECHANICS RESEARCH CENTER, WATERTOWN, MA	198	54

PERCENT HIGH GRADE S&E (GS 13-15) IN DOD LABS, Cont.

ARMY, CONT.	CIVILIAN S&E	PERCENT HIGH GRADE
BALLISTICS RESEARCH LAB, ABERDEEN PROVING GROUND, MD	403	53
RESEARCH & TECHNOLOGY LABS, MOFFETT FIELD, CA	249	53
ARMY RESEARCH INST., ALEXANDRIA, VA	200	52
ATMOSPHERIC SCIENCES LAB, WHITE SANDS MISSILE RANGE, NM	98	52
MEDICAL BIOENGINEERING R&D LAB, FREDERICK, MD	36	50
MEDICAL RESEARCH INST. OF CHEM. DEFENSE, ABERDEEN PROVING GROUND, MD	41	49
FIRE CONTROL & SMALL CAL. WEAPON SYSTEMS LAB, DOVER, NJ	419	49
ELECTRONICS WARFARE LAB, FT. MONMOUTH, NJ	203	48
COMMUNICATIONS-ELECTRONICS R&D CENTER, FT. MONMOUTH, NJ	84	48
COMMUNICATIONS SYSTEMS CENTER, FT. MONMOUTH, NJ	155	46
COLD REGIONS R&E LAB, HANOVER, NH	110	46
CHEMICAL SYSTEMS LAB, ABERDEEN PROVING GROUND, MD	434	44
BENET WEAPONS LAB, WATERVLIET, NY	129	44
HUMAN ENGINEERING LAB, ABERDEEN PROVING GROUND, MD	101	43
CONSTRUCTION ENGINEERING RESEARCH LAB, CHAMPAIGN, IL	112	42

PERCENT HIGH GRADE S&E (GS 13-15) IN DOD LABS, Cont.

ARMY, CONT.	CIVILIAN S&E	PERCENT HIGH GRADE
LETTERMAN ARMY INST. OF RESEARCH, PRESIDIO OF SAN FRANCISCO, CA	31	39
ENGINEER WATERWAYS EXPERIMENT STATION, VICKSBURG, MS	507	38
LARGE CAL. WEAPON SYSTEMS LAB, DOVER, NJ	1,042	37
AEROMEDICAL RESEARCH LAB, FT. RUCKER, AL	19	37
WALTER REED ARMY INST. OF RESEARCH, WASHINGTON, DC	148	36
MEDICAL RES. INST. OF INFECTIOUS DISEASES, FREDERICK, MD	59	36
RESEARCH INST. OF ENVIRONMENTAL MEDICINE, NATICK, MA	36	36
NATICK R&D LABS, NATICK, MA	314	34
INSTITUTE OF DENTAL RESEARCH, WASHINGTON, DC	4	25
INSTITUTE OF SURGICAL RESEARCH, FT. SAM HOUSTON, TX	15	13

PERCENT HIGH GRADE S&E (GS 13-15) IN DOD LABS, Cont.

NAVY	CIVILIAN S&E	PERCENT HIGH GRADE
NAVAL RESEARCH LAB, WASHINGTON, DC	1,327	66
NAVAL BIODYNAMICS LAB, NEW ORLEANS, LA	21	62
NAVAL ENVIRONMENTAL PREDICT. RESEARCH FAC., MONTEREY, CA	20	55
NAVAL OCEAN R&D ACTIVITY, BAY ST. LOUIS, MS	134	52
NAVAL WEAPONS CENTER, CHINA LAKE, CA	1,290	50*
NAVAL OCEAN SYSTEM CENTER, SAN DIEGO, CA	1,280	50*
NAVAL DENTAL RESEARCH INSTITUTE, GREAT LAKES, IL	4	50
DAVID W. TAYLOR NAVAL SHIP R&D CENTER, BETHESDA, MD	1,148	46
NAVAL AERO. MEDICAL RESEARCH LAB, PENSACOLA, FL	20	45
NAVAL SURFACE WEAPONS CENTER, DAHLGREN, VA	2,027	44
NAVAL CIVIL ENGINEERING LAB, PORT HUENEME, CA	168	40
NAVAL COASTAL SYSTEMS CENTER, PANAMA CITY, FL	286	37
NAVY PERSONNEL R&D CENTER, SAN DIEGO, CA	155	37
NAVAL SUBMARINE MEDICAL RESEARCH LAB, NEW LONDON, CT	25	36

*ASSUMES HALF OF LEVEL III CIVILIANS ARE HIGH GRADE

PERCENT HIGH GRADE S&E (GS 13-15) IN DOD LABS, Cont.

NAVY (CONT.)	CIVILIAN S&E	PERCENT HIGH GRADE
NAVAL UNDERWATER SYSTEMS CENTER, NEWPORT, RI	1,393	35
NAVAL AIR DEVELOPMENT CENTER, WARMINSTER, PA	1,129	35
NAVAL AIR PROPULSION CENTER, TRENTON, NJ	157	34
NAVAL MEDICAL RESEARCH INSTITUTE, BETHESDA, MD	64	28
NAVAL HEALTH RESEARCH CENTER, SAN DIEGO, CA	19	21
NAVY CLOTHING AND TEXTILE RESEARCH FAC., NATICK, MA	37	19
NAVAL BIOSCIENCES LAB, OAKLAND, CA	0	--

PERCENT HIGH GRADE S&E (GS 13-15) IN DOD LABS, Cont.

AIR FORCE	CIVILIAN S&E	PERCENT HIGH GRADE
ENGINEERING SERVICES LAB, TYNDALL AFB, FL	13	85
AF GEOPHYSICS LAB, HANSCOM AFB, MA	284	74
AF WRIGHT AERONAUTICAL LAB, WRIGHT-PATTERSON AFB, OH	1,361	63
AF ROCKET PROPULSION LAB, EDWARDS AFB, CA	109	61
ROME AIR DEVELOPMENT CENTER, GRIFFIS AFB, NY	610	59
AF WEAPONS LAB, KIRTLAND AFB, NM	220	58
AF AEROSPACE MEDICAL RESEARCH LAB, WRIGHT-PATTERSON AFB, OH	84	55
AF ARMAMENT LAB, EGLIN AFB, FL	198	52
USAF SCHOOL OF AEROSPACE MEDICINE, BROOKS AFB, TX	107	45
AF HUMAN RESOURCES LAB, BROOKS AFB, TX	103	45
FRANK J. SEILER RESEARCH LAB, USAF ACADEMY, CO	5	0

CHART 36

This chart summarizes the comments of the laboratory directors on impacts of civilian high-grade limits. The thrust of these comments is that restrictions on ability to promote people or to hire them at high grades causes difficulty. Directors perceive that selected S&E are performing at higher grade levels while S&E perceive lack of career development potential. Thus, acquiring experienced people is difficult, and generally some of the best people will leave the laboratory because they feel that they should be promoted sooner than the system allows. This leads to reduced quality work, both because of the limited supervision in-house and because less experienced people are managing contracts.

IMPACTS OF CIVILIAN HIGH GRADE (GS 13-15) LIMITS

LAB DIRECTORS REPORT

- LIMITED ABILITY TO HIRE EXPERIENCED PEOPLE
- LOSS OF SOME OF BEST PEOPLE
- LIMITED ABILITY TO PROMOTE DESERVING PEOPLE
- SOME GS-12'S DOING GS-13 LEVEL WORK
- REDUCED QUALITY OF WORK
  - IN-HOUSE BECAUSE OF LIMITED SUPERVISION
  - CONTRACT MANAGEMENT BECAUSE OF LOWER EXPERIENCE

CHART 37

Here we show the general schedule salary scale in effect in April 1982. The normal progression for professional personnel is entry at GS-5 or GS-7, Step 1 level with annual promotion generally through GS-9. The entry level for someone possessing a masters degree is GS-9, while the entry level for someone possessing a doctorate is GS-12. There are certain scarce skills (mostly engineers) which are paid a higher salary as shown by boxes in this table in grades GS-5 through 11 based on an OPM approved special salary rate. For entering GS-5 and GS-7 the initial salary is Step 10, with nine additional steps available carrying the same step increase (i.e., $428 for GS-5 and $531 for GS-7). GS-9 may enter at Step 8 and GS-11 at Step 4. A GS-5 will come in at Step 10, be promoted within six months or a year to GS-7/Step 10, then, a year later to GS-9/Step 8 and finally to GS-11/Step 4. Thereafter advancement follows the general schedule, as shown.

GS	GENERAL SCHEDULE IN EFFECT IN APRIL 1982										Amt. of Step Incr.
	1	2	3	4	5	6	7	8	9	10	
1	$8,342	$8,620	$8,898	$9,175	$9,453	$9,615	$9,890	$10,165	$10,178	$10,439	Varied
2	9,381	9,603	9,913	10,178	10,292	10,595	10,898	11,201	11,504	11,807	Varied
3	10,235	10,576	10,917	11,258	11,599	11,940	12,281	12,622	12,963	13,304	$341
4	11,490	11,873	12,256	12,639	13,022	13,405	13,788	14,171	14,554	14,937	383
5	12,854	13,282	13,710	14,138	14,566	14,994	15,422	15,850	16,278	16,706	428
6	14,328	14,806	15,284	15,762	16,240	16,718	17,196	17,674	18,152	18,630	478
7	15,922	16,453	16,984	17,515	18,046	18,577	19,108	19,639	20,170	20,701	531
8	17,634	18,222	18,810	19,398	19,986	20,574	21,162	21,750	22,338	22,926	588
9	19,477	20,126	20,775	21,424	22,073	22,722	23,371	24,020	24,669	25,318	649
10	21,449	22,164	22,879	23,594	24,309	25,024	25,739	26,454	27,169	27,884	715
11	23,566	24,352	25,138	25,924	26,710	27,496	28,282	29,068	29,854	30,640	786
12	28,245	29,187	30,129	31,071	32,013	32,955	33,897	34,839	35,781	36,723	942
13	33,586	34,706	35,826	36,946	38,066	39,186	40,306	41,426	42,546	43,666	1120
14	39,689	41,012	42,335	43,658	44,981	46,304	47,627	48,950	50,273	51,596	1323
*15	46,685	48,241	49,797	51,353	52,909	54,465	56,021	57,577	59,133	60,689	1556
*16	54,755	56,580	58,405	60,230	62,055	63,880	65,705	67,530	69,355		1825
*17	64,142	66,280	68,418	70,556	72,694						2138
*18	75,177										

**The rate of basic pay payable to employees at these rates is limited to $57,500, the rate payable for level V of the Executive Schedule.*

CHART 38

This chart provides a comparison of DOD laboratory and industry salaries in 1978 and 1981. Although salary alone does not represent total compensation, it serves as a useful quantifiable element for purposes of comparison. The DOD figures are based on data from the Defense Manpower Data Center and are averaged for both scientists and engineers. Within the DOD laboratories our data indicates that the average compensation of scientists does not differ significantly from that of engineers. The industry figures are taken from a private sector salary survey of a sample of engineers, most of whom are engaged in aerospace and weapons work. The 1981 survey reflects data gathered from 107 companies and represents more than 347,000 employees, of whom over 161,000 are engineers. The minimum DOD salary reported is $12,200; the maximum $50,100. In the private sector survey, the minimum salary reported was 12,500; the cut-off was $70,000. The average age of the two groups are nearly identical in 1981, 42.2 years in DOD labs and 42.4 years in the industry survey.

Both in 1978 and 1981, the DOD salary was higher than that of the industry population; however, in 1981, the averages are quite close to one another. The increase in DOD Lab S&E salary is 23 percent which compares with the 21 percent increase in general salary schedule over the same period. Over the same period the industry engineers in the private sector had a salary increase of 31 percent. Comparative effects of inflation will be dealt with two charts hence. The comparability of average DOD and private sector salaries in 1981 should not be used to conclude that there is no salary problem. The next charts more fully clarify the situtation.

S&E AVERAGE ANNUAL SALARY COMPARISON

(THOUSANDS OF DOLLARS)

	1978	1981
DOD LABORATORY S&E	28.5	35.0
INDUSTRY ENGINEERS (PRIVATE SECTOR SURVEY)	2[illegible].3	34.5

CHART 39

This chart continues the comparison of private sector salaries and those paid to the DOD laboratory scientists and engineers. The chart shows the average annual salary versus age. The entry level salaries paid by DOD are clearly significantly less than those paid in the non-government sector. There is a crossover about age 43. The average salary decreases past age 53 in both populations.

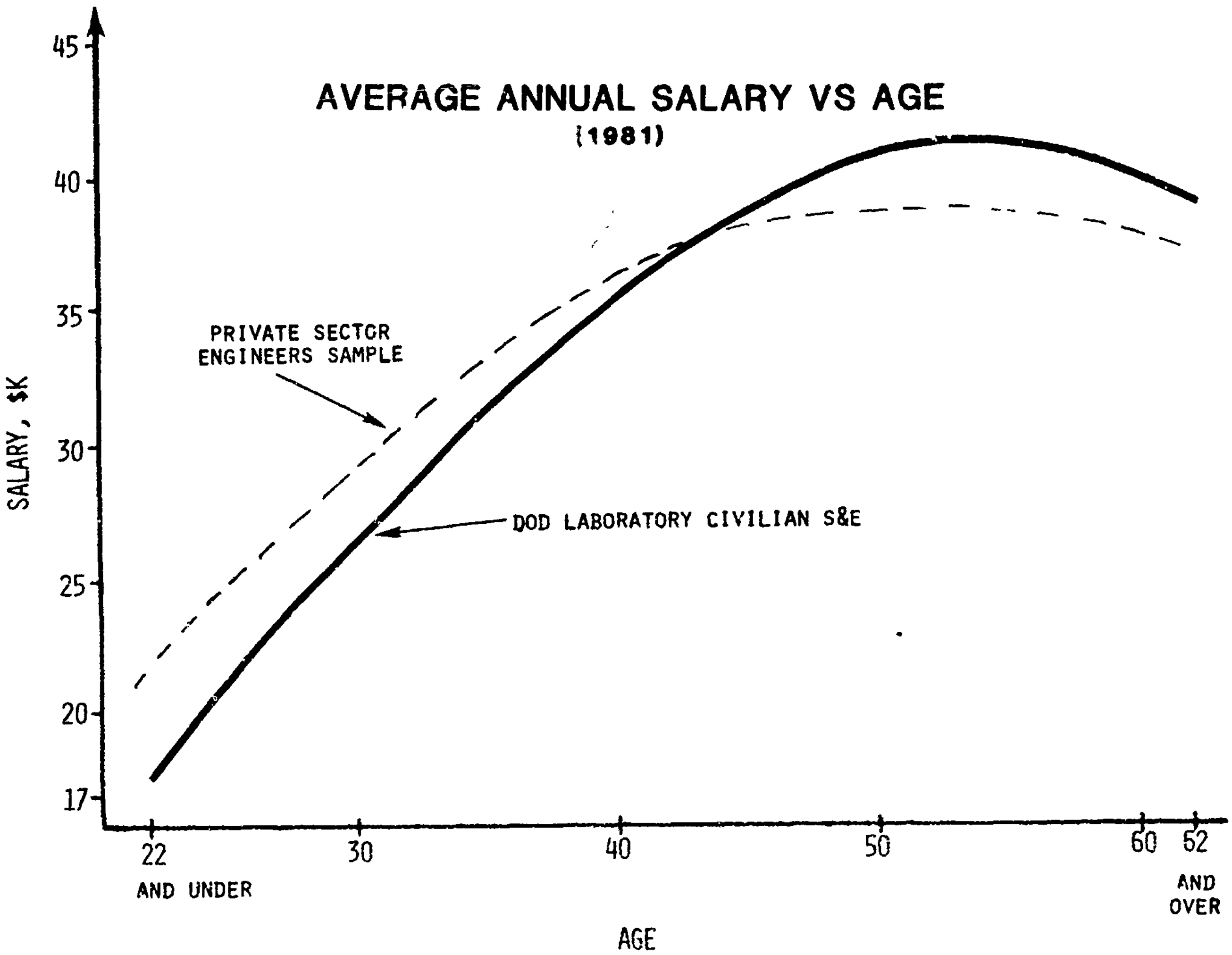

AVERAGE ANNUAL SALARY VS AGE
(1981)
SALARY, $K
45
40
35
30
25
20
17
PRIVATE SECTOR ENGINEERS SAMPLE
DOD LABORATORY CIVILIAN S&E
22 AND UNDER
30
40
50
60
62 AND OVER
AGE

CHART 40

These data compare the average salaries of DOD laboratory engineers with non-governmental engineers in industry at equivalent levels of responsibility. The DOD lab data developed in the current study using DMDC data for 30 September 1981 are plotted as a function of GS-grade level, GS-5 through GS-15. The industry data were determined as of March 1981 in a study by the Bureau of Labor Statistics (BLS) which matched industry engineers to "equivalent" levels of responsibility as exists at the GS-grade levels of GS-5 through GS-15 in the government. The chart also shows the percent difference between the average DOD lab engineer's salary with that of his "equivalent" industry counterpart. As for example, at the GS-12 level, the average DOD laboratory engineer salary is $31,602 while his industry equivalent, determined by BLS, is earning $36,725, a difference of 16 percent. Two points are noteworthy. At all grade levels industry average engineer salaries exceed those in the DOD labs at equivalent levels of duties and responsibility. Second, the differences are particularly large (39% and 21%) at the entry GS-5 and GS-7 levels. The BLS data were taken from a study, "National Survey of Professional, Administrative, Technical, and Clerical Pay, March 1981", U.S. Department of Labor Statistics, September 1981, Bulletin 2108.

Although comparable data were not available for scientists as a group, the BLS study cited above did provide information on chemists in similar fashion to that of engineers. In brief, the results showed the same general trends as the engineers, however, the chemists showed larger percentage differences in grades GS-5 through GS-9 and smaller percentage differences in GS-12 and above.

The salary data derived from the BLS survey is consistent with the previous two charts when one considers the greater proportion of scientists and engineers in the DOD laboratories compared to those in industry at higher levels of responsibility.

ENGINEERS AVERAGE ANNUAL SALARY VS. GRADE

(1981)

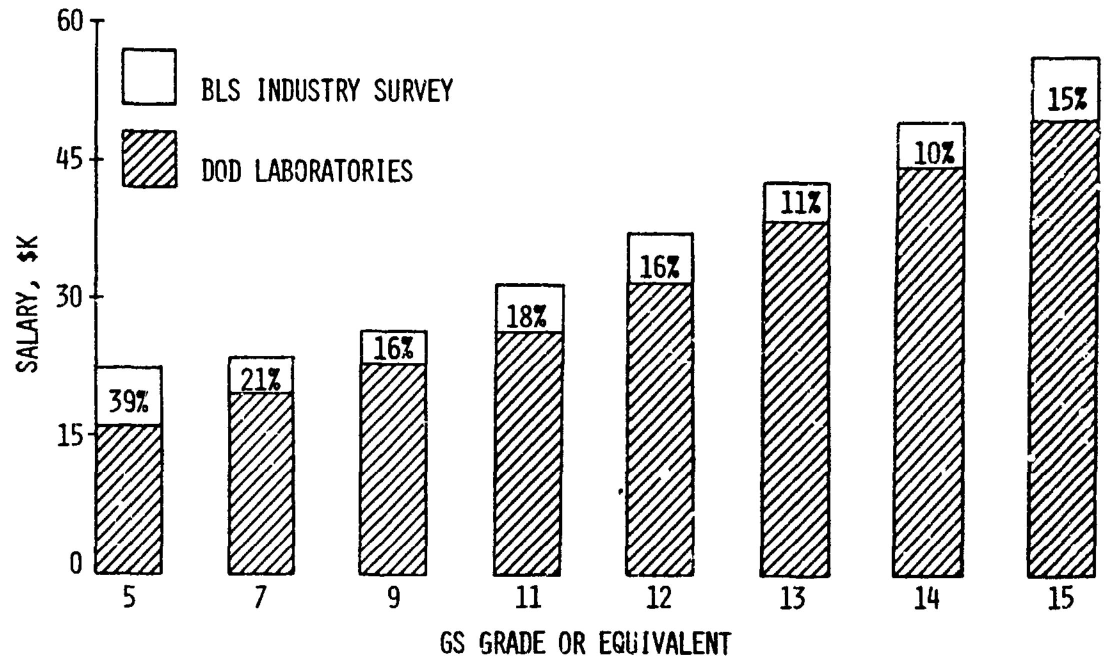


CHART 41

Another comparison of interest is the erosion of real salary during the past five years. The data show the average salary deflated for private sector engineers with 14 to 15 years of experience and those with 20 to 21 years of experience. In each case, the decline was somewhat over seven percent in real terms. The consumer price index (CPI) was applied annually taking 1977 as the base year. These industry private sector data were obtained from the same unpublished study as referred to previously. Also shown is the average Department of Defense laboratory scientist and engineer salary deflated using the consumer price index. In these data, though there has been a 32 percent salary increase in current dollars, there has been a 12.7 percent decline in constant dollars, somewhat over five percent more than that in industry. (In order to find comparable salaries for this chart, we noted that the average years of federal service of the DOD lab S&E work force was 16.5 years. It seemed reasonable, then, to compare their salary with engineers of comparable experience from the private industry survey bracketed between 14-15 years and 20-21 years. In this comparison, it is necessary to keep in mind that federal service does not necessarily include total years of experience.)

AVERAGE SALARY TRENDS (CONSTANT 1977 DOLLARS)

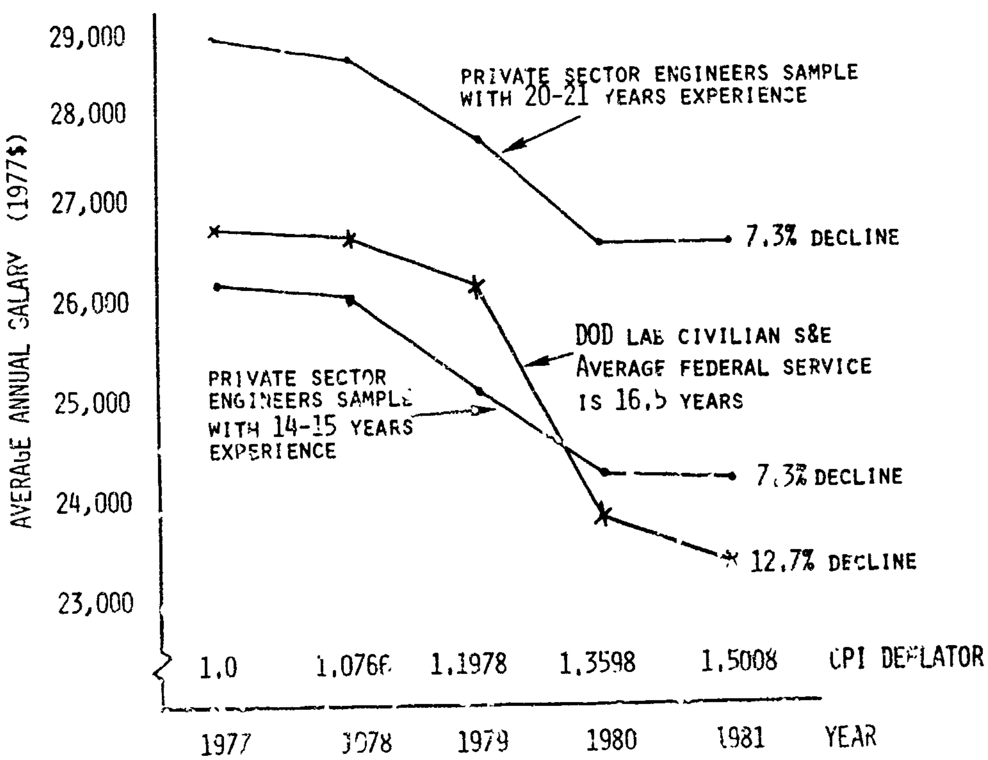


CHART 42

From this section, we have seen that the educational achievements of the laboratory S&E compare favorably with those of the national group and have been relatively constant over the five year period 1977-1981. Because of the decrease in advanced degrees being awarded, it is reasonable to be concerned about a potential decline in laboratory advanced degree population. Almost half of the scientist and engineer civilians are in the high grade group and this percentage has been relatively constant over the five year period. However, there is a great variation in the percentages among the laboratories. Despite this level of high grade scientists and engineers, the laboratory directors were almost uniform in reporting significant adverse impact from high grade controls. A service breakdown shows high grades among the Air Force and Navy S&E's decreasing over the period 1977-81, as shown in Appendix D to this report.

Salary comparisons between industry and the DOD laboratories alone do not adequately describe the entire compensation situation. The current study shows that entry level salaries are significantly below industry levels. Beyond age 43, the average DOD laboratory scientist and engineer salaries are higher than a private sector engineer sample. The Bureau of Labor Statistics, however, has developed recent data which show the equivalency of industry engineering salaries to those in government for the same level of duties and responsibilities. At all GS levels from 5 to 15 DOD lab salaries lag by amounts from 10 percent to 39 percent. In real terms, we found that all salaries lost ground to inflation, but in the DOD laboratories the drop was nearly twice that experienced in industry.

SUMMARY: EDUCATION AND SALARY

- Lab and National S&E Education Similar
- Lab S&E Educational Levels and Grade Distribution Relatively Constant (1977-81)
- Potential Decline in Lab Advanced Degree Population
- 48% of S&E Civilians Are High Grade (GS 13-15)
- Wide Variation of High Grades Among Labs
- Directors Report Significant adverse Impact of High Grade Control
- Entry Level Salaries Are Significantly Below Industry Levels
- Beyond age 43 DOD Lab S&E Salaries on Average Are Higher Than Private Sector Engineers Sample
- For Equivalent Levels of Responsibility, DOD Lab Engineering Salaries Lag Industry Salaries from 10 to 39 Percent
- In Real Terms, From 1977 to 1981, Average S&E Salary Dropped by Almost 13% in DOD Labs While Dropping 7.3% in Industry

Chart 43

This section presents data on discipline and skill populations and shortages. Long term needs are identified and compared with the national situation. Impacts of the shortages are summarized.

V. S&E DISCIPLINES &
SKILL SHORTAGES

V. S&E DISCIPLINES & SKILL SHORTAGES

CHART 44

Shown here is the distribution of the DOD laboratory scientists and engineers by discipline. Again, we see that there are more engineers than scientists. Of the engineering group, by far the largest category is electrical and electronics engineers. Among scientists, physicists are the largest with the other major groups being chemists and mathematicians and statisticians. Computer scientists account for only 275 of the civilians. Computer scientists and other computer professionals are not fully accounted for due to their distribution among other discipline categories.

DOD LAB S&E BY DISCIPLINE

(SEPTEMBER 30, 1981)

<table>
<tr><th>ENGINEERS</th><th>CIVILIAN</th><th>MILITARY</th></tr>
<tr><td>ELECTRICAL/ELECTRONIC</td><td>5,916</td><td>256</td></tr>
<tr><td>MECHANICAL</td><td>2,663</td><td>283</td></tr>
<tr><td>AERONAUTICAL</td><td>1,364</td><td>250</td></tr>
<tr><td>GENERAL</td><td>1,893</td><td>18</td></tr>
<tr><td>OTHER</td><td>1,661</td><td>199</td></tr>
<tr><td>TOTAL ENGINEERS</td><td>13,497</td><td>1,006</td></tr>
<tr><td>SCIENTISTS</td><td></td><td></td></tr>
<tr><td>PHYSICS</td><td>3,303</td><td rowspan="2">364</td></tr>
<tr><td>CHEMISTRY</td><td>1,198</td></tr>
<tr><td>MATH/STATISTICS</td><td>1,931</td><td rowspan="2">10</td></tr>
<tr><td>COMPUTER SCIENCE</td><td>275</td></tr>
<tr><td>OTHER</td><td>1,563</td><td>541</td></tr>
<tr><td>TOTAL SCIENTISTS</td><td>8,270</td><td>915</td></tr>
<tr><td>TOTAL S&E</td><td>21,767</td><td>1,921</td></tr>
</table>

CHART 45

This chart compares the laboratory S&E population with the national population as found by the National Science Foundation 1980 survey. Note that the laboratory work force has a preponderance of engineers, while nationally the proportion is slightly in favor of scientists. The distribution of disciplines within the engineering and science fields is also different in the DoD laboratories. The electrical and electronics engineers account for 44 percent of all the engineers versus 18 percent in the national work force. In the scientists grouping, physcial sciences account for an extremely large number of the laboratory population. The "physical sciences" include mostly chemistry and physics and also include geophysics, metallurgy, astronomy and space science, and meteorology. Computer scientists are a small number of the DoD work force as indicated by job series as in comparison with 23 percent of the national population. The 'computer scientist' job series does not properly account for the total computer professionals within the DOD laboratories. Many are subsumed, for example, under engineering job series titles. It should also be noted that computer scientists are not eligible for the special salary rates available for most engineers.

COMPARISON OF DOD LAB AND NATIONAL (NSF) DATA FOR CIVILIAN S&E

(1980 DATA IN PERCENT)

ITEM	DOD LABS	NATIONAL
WORK FORCE		
ENGINEERS	62	48
SCIENTISTS	38	52
	100	100
ENGINEERS		
ELECTRICAL/ELECTRONIC	44	18
MECHANICAL	20	17
AERONAUTICAL	10	3
CIVIL	4	14
CHEMICAL	3	5
ALL OTHER	19	43
	100	100
SCIENTISTS		
PHYSICAL	57	15
MATHEMATICAL	23	8
SOCIAL	7	22
LIFE	6	25
COMPUTER	3	23
ENVIRONMENTAL	3	6
	100	100

CHART 46

This chart shows the vacancies reported by the laboratory directors as of the end of fiscal year 1981. A brief word is in order as to the definition of vacancy. In the questionnaire, from which these data were drawn, we were careful to define vacancy not only as an empty slot, but also as any position which would have been filled by a scientist or engineer if available.

In terms of numbers, the greatest need is for electrical/electronics engineers. However, that number represents only five percent of the EE population. Only computer scientists, mechanical engineers, or psychologists have vacancy rates above five percent. In FY 1981, the new hire skill distribution nominally matched the existing discipline distribution within the laboratories.

CURRENT S&E NEEDS BY DISCIPLINE

(SEPTEMBER 30, 1981)

- LABORATORY DIRECTORS REPORT THE FOLLOWING CIVILIAN VACANCIES

CATEGORY	LABORATORY POPULATION	VACANCIES	%
ELECTRICAL/ELECTRONICS ENGINEERS	5,916	308	5
COMPUTER SCIENTISTS	275	23	8
MECHANICAL ENGINEERS	2,663	188	7
PSYCHOLOGISTS	527	63	12
PHYSICISTS	3,303	130	4
GENERAL ENGINEERS	1,893	101	5
AERONAUTICAL ENGINEERS	1,364	75	5
OTHER ENGINEERS	2,667	90	3
OTHER SCIENTISTS	5,080	177	3
	23,688	1,155	5

CHART 47

Over the long term, laboratory directors projected the need for increased scientist and engineer talent as shown. Thirty-two laboratories forecast no needed change from current skill mix. The Army and Navy laboratory directors indicated a need for a significant increase in military scientists and engineers. The objective was to increase the operational knowledge available to their technical work force.

LONG TERM S&E SKILL NEEDS

- LABORATORY DIRECTORS REPORT THE FOLLOWING:

Computer Science	Acoustics	System Engineering
Computer Networking	Ocean Engineering	Control System Engineering
Artificial Intelligence	Geophysics	Manufacturing Engineering
Robotics/Automation	Sensor Technology	Materials Engineering
Signal Processing	Infrared	Ceramics
Digital Communications	Fiber Optics	Physical Chemistry
		Biomechanics

- 32 Labs With 43% of S&E Forecast No Needed Change in Current Skill Mix

- Army and Navy Labs Desire Significant Increase in Military S&E (140% and 70%, Respectively)

CHART 48

Fifty-two laboratories, having 62 percent of the S&E population, reported impacts on 142 of their programs. Electronics and computers were involved in many of the programs mentioned. Eighteen of the laboratories, with 19 percent of the scientists and engineers, mentioned specific expertise that was needed. On the other hand, 19 of the laboratories, with 38 percent of the scientist and engineer population, reported no impact from vacancies.

MISSION IMPACTS OF VACANCIES

- 52 LABS WITH 62% OF S&E REPORTED IMPACTS ON 142 PROGRAMS
  - IMPACTS INCLUDE DELAYS, PROGRAM REFUSAL, INCREASED RISKS, LOSS OF LEADERSHIP POSITION
  - ELECTRONICS, COMPUTERS MOST AFFECTED
  - 18 LABS WITH 19% OF S&E REPORTING IMPACT HAD DIFFICULTY FINDING SPECIFIC EXPERTISE
- 19 LABS WITH 38% OF S&E REPORTED NO IMPACT

CHART 49

This chart shows the national situation in scientists and engineers as recorded by the studies that were reviewed. (See Appendix F of this report.) It is a matter of concern that there are real shortages of faculty. This is coupled with the fact that engineering Ph.D. production is down and almost half of the degrees being awarded are to foreign nationals. There has been a decline of science and technology education in the secondary schools. Engineering manpower needs are unpredictable, because they are linked to economic activity.

NATIONAL STUDIES OF SCIENTISTS & ENGINEERS

GENERAL RESULTS

- REAL SHORTAGES IN ENGINEERING FACULTY
- S&E EMPLOYMENT 1970-80 LINKED TO ECONOMIC ACTIVITY
  - OSCILLATIONS PARTICULARLY APPARENT FOR ENGINEERS
- SCIENCE & TECHNOLOGY EDUCATION IN SECONDARY SCHOOLS DECLINING
  - 15 YEAR DECLINE IN SAT SCORES
- ENGINEERING PHD PRODUCTION DOWN; HALF FOREIGN NATIONALS
- ALL STUDIES AND FORECASTS ARE BASED ON AGGREGATE SUPPLY AND DEMAND DATA, AND MAY OVERLOOK SHORTAGES OF SOME SUBSPECIALTIES AND MULTI-DISCIPLINARY SKILLS

CURRENT SITUATION

- COMPUTER SCIENCES; ELECTRONIC/ELECTRICAL, INDUSTRIAL ENGINEERS IN SHORT SUPPLY
- NUCLEAR, MECHANICAL AND AERONAUTICAL ENGINEERS, PHYSICISTS AND CHEMISTS IN BALANCE
- ENGINEERING MANPOWER NEEDS UNPREDICTABLE BUT LARGE SHORTAGE OF PHD AND COMPUTER SCIENCES REMAIN

FORECAST

- ANNUAL SHORTAGES OF COMPUTER SCIENCES WILL INCREASE THRU 1985-90. BY 1990 SUPPLY OF S&E SHOULD BE ADEQUATE EXCEPT COMPUTER PROFESSIONALS, STATISTICIANS, AND INDUSTRIAL ENGINEERS.

CHART 50

This chart summarizes the findings on scientists and engineers discipline and skill shortages. Electrical and electronics engineers constitute the largest portion by far of the laboratory engineering population; and physical scientists constitute over half of the scientists population. It is noteworthy that computer scientists comprise only three percent of the laboratory scientists but are present in other job series. There is a mixed picture of shortages in the DOD laboratories.

In the near term, vacancies constitute a small percentage of the population with some mission impacts cited as resulting from vacancies. In the longer term, the skills needed tend to be highly specialized and highly multi-disciplinary. The projected national trends reasonably match the projections cited by the DOD laboratories.

SUMMARY: S&E DISCIPLINES AND SKILL SHORTAGES

- EE'S CONSTITUTE 44% OF LAB ENGINEERS (27% OF LAB S&E)
- PHYSICAL SCIENTISTS CONSTITUTE 57% OF LAB SCIENTISTS
- COMPUTER SCIENTISTS CONSTITUTE 3% OF LAB SCIENTISTS, BUT ARE PRESENT IN OTHER JOB SERIES
- DOD LAB DISCIPLINES DIFFER FROM NATIONAL DISTRIBUTION
- MIXED PICTURE IN DOD LABS ON SHORTAGES

  CURRENT
  - NEEDS ARE SMALL PERCENTAGE OF POPULATION
  - MISSION IMPACTS OF SKILL SHORTAGES WERE CITED

  LONG TERM
  - SKILLS SPECIFIED HIGHLY SPECIALIZED AND MULTI-DISCIPLINARY
  - 30 LABS FORECAST NO NEEDED SKILL CHANGES
  - ARMY AND NAVY DESIRE MORE MILITARY S&E

- LAB SKILL SHORTAGES REASONABLY MATCH PROJECTED NATIONAL TRENDS

CHART 51

Data on recruitment and retention are presented in this section. In particular, accessions, attrition, and promotions are analyzed. The quality of the work force (particularly entry level hires) is assessed, and the factors which either strengthen or weaken recruitment and retention are enumerated. The subjects of bureaucratic constraints and the dual career ladder are discussed.

VI. RECRUITMENT AND RETENTION

VI. RECRUITMENT AND RETENTION

CHART 52

This chart shows the personnel transactions during fiscal year 1981 at the laboratories. These transactions are shown by grade. The first column after the grade indications shows the end strength of each grade for fiscal 1980. The final column shows the end strength for fiscal 1981. This number is the FY 80 strength minus losses and promotions out of grade plus promotions into grade and gains to the laboratory system. We can see from this chart that grades 12 and 13 represent the largest group in the laboratories. Most of the gains are at the entry level (i.e., GS-5 and GS-7) with GS-12 gains showing a peak that included Ph.D accessions. We will deal with the losses and the gains in each grade in subsequent charts.

CIVILIAN S&E PERSONNEL TRANSACTIONS
(FY 1981)

Grade	End Strength FY 1980	Loss From Lab System	Promotions Out of Grade	Promotions Into Grade	Gain to Lab System	End Strength FY 1981
GS-5	124	23	102	—	135*	134
GS-7	564	72	420	102	425*	599
GS-9	868	65	490	420	210	943
GS-11	1,875	134	540	490	201	1,892
GS-12	7,544	475	524	540	427	7,512
GS-13	6,050	319	312	524	80	6,023
GS-14	3,071	174	144	312	70	3,135
GS-15	1,282	104	19	144	31	1,334
Total	21,378	1,366	2,551	2,532	1,579	21,572
Percent		6.4	11.9		7.4	

* At many DoD Labs, new accessions at this grade are eligible for promotion after 6 months.

CHART 53

This chart shows the number of people entering the indicated grades during fiscal year 1981. The white segments of the bar graphs represent personnel gained from outside hires and transfers. The crosshatched segments represent those gained from promotion. After the entry levels (GS-5/7), the majority of gains in each grade are from promotions.

SOURCE OF PERSONNEL FOR CIVILIAN S&E BY GRADE
(FY 1981)

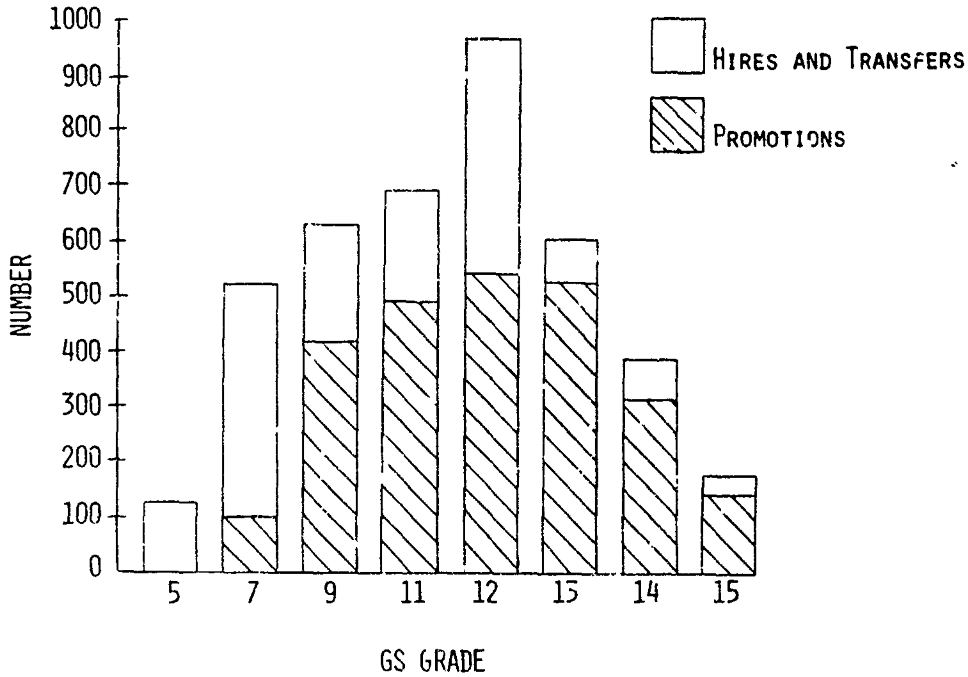


CHART 54

This chart provides an analysis of the losses from the laboratory system. The first column after the grade indicator shows the beginning population. The second column shows the percentage of those personnel who left the laboratory system during the year, as computed from the actual losses shown in the next column. The highest percentages are at the entry level, which is to be expected because the entry level is the point where the employee and the employing organization discover whether the relationship will be mutually satisfying. For grades above the entry level, the loss rate is quite small -- rising again slightly at the GS-15 level. The overall loss rate for all grades is 6.4%. Based on discussions with industry associations, this loss rate is lower than national experience, where in the disciplines predominant in the DOD laboratories, loss rates in the 10 to 20 percent range are common. Because of the large number of people in the GS-12 and GS-13 grades, the number leaving is greatest at those grades -- even though it amounts only to approximately six percent loss of the work force. The fourth column distributes the total losses by grade. Almost 60 percent of those leaving the laboratories are GS-12s and GS-13s.

CIVILIAN S&E LOSS FROM LAB SYSTEM

(FY 1981)

GS	End Strength FY 1980	Loss Rate	Loss From Lab System	Distribution of Total Loss
5	124	18.5%	23	1.7%
7	564	12.8	72	5.3
9	868	7.5	65	4.8
11	1,875	7.1	134	9.8
12	7,544	6.3	475	34.8
13	6,050	5.3	319	23.4
14	3,071	5.7	174	12.7
15	1,282	8.1	104	7.6
Total	21,378	6.4%	1,366	100.0%

CHART 55

In the questionnaire, laboratory directors were asked to rate as highly influential, moderately influential, or slightly influential various reasons that civilians might have had for leaving. Opportunity for advancement elsewhere and salary were the predominant factors.

REASONS FOR LEAVING

LABORATORY DIRECTORS REPORT:

- OPPORTUNITY FOR ADVANCEMENT ELSEWHERE AND SALARY PRIMARY REASONS FOR LEAVING

- FOR GS-12 AND BELOW, LACK OF OPPORTUNITY FOR ADVANCEMENT IMPORTANT

- FOR GS-13 AND ABOVE, PERCEIVED REDUCTION IN FEDERAL BENEFITS SIGNIFICANT FACTOR

CHART 56

This chart shows the promotion rate for GS-9 to GS-15. Promotion rates are highest in GS-9 and GS-11. At the higher grades promotions are slowed significantly. Less than eight percent of those who begin the year as GS-12 can expect to be promoted that year. The average dwell period would appear to be thirteen years, however, not all GS-12s are promotable.

CIVILIAN S&E PROMOTIONS
(FY 1981)

GS GRADE	NUMBER ELIGIBLE	PERCENT PROMOTED
9	803	61.0
11	1741	31.0
12	7069	7.4
13	5731	5.4
14	2897	5.0
15	1178	1.6

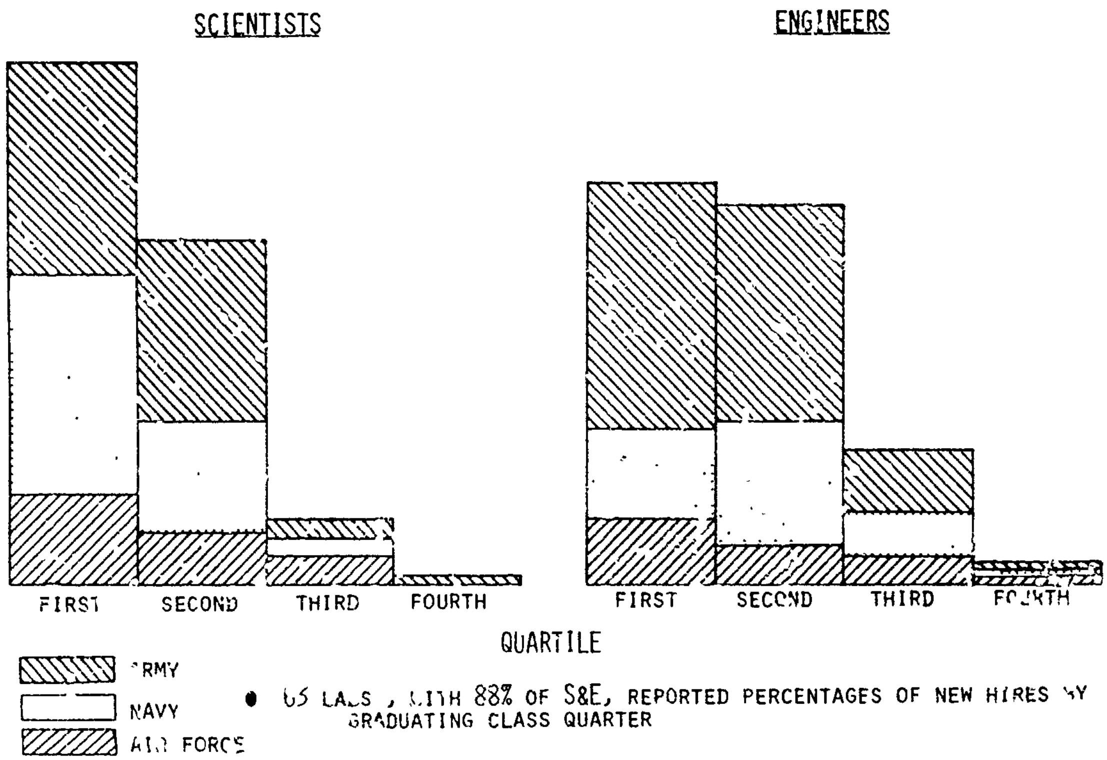
CHART 57

This chart addresses the class standing of baccalaureate hires by the laboratories. Laboratories reported the percentage of their new S&E hires from each quartile of their graduating class. Each laboratory's data have been compiled in a relative distribution by quartile as shown. A larger fraction of scientists hired were in the top quartile than engineers. Further, more engineers were hired from the lower half of the class than scientists. The relative distribution of hires among quartiles is consistent within each service, but the size of blocks between services is skewed because the Army has a large number of laboratories and the Air Force has a small number. No attempt has been made to correlate the quartiles reported with the national standing of the educational institutions from which lab hiring occurred.

QUALITY OF ENTRY LEVEL HIRES

RELATIVE RATIOS BY GRADUATING CLASS STANDING

FY 1981



• 65 LABS, WITH 88% OF S&E, REPORTED PERCENTAGES OF NEW HIRES BY GRADUATING CLASS QUARTER

CHART 58

This chart provides the comments of the laboratory directors on the quality of their work force. The majority of directors believe that their work force is good to excellent, while a smaller majority believe that the work force is current in its field. Only 21 percent of the directors feel that the new hires are better than they were five to ten years ago, while another 37 percent believe that the quality is the same.

LABORATORY S&E QUALITY

LABORATORY DIRECTORS REPORT:

- QUALITY OF WORK FORCE

  80% REPORT GOOD-TO-EXCELLENT, VERY HIGH
  20% REPORT FAIR-TO-GOOD, ADEQUATE

- CURRENCY OF WORK FORCE

  60% REPORT GOOD-TO-EXCELLENT, VERY HIGH
  40% REPORT FAIR-TO-GOOD, ADEQUATE

- QUALITY OF ENTRY & JOURNEYMAN LEVEL HIRES (COMPARED TO 5-10 YEARS AGO)

  21% REPORT HIGHER
  37% REPORT SAME
  27% REPORT NOT AS HIGH
  15% MADE NO RESPONSE

CHART 59

This chart continues to highlight comments pertaining to quality made by the laboratory directors. The comments address some of the problems in attracting and retaining quality personnel in the laboratories.

LABORATORY DIRECTORS REPORT (CONTINUED):

- UNABLE TO COMPETE FOR BEST GRADUATES AND HIGH QUALITY EXPERIENCED JOURNEYMEN ON BASIS OF PAY AND BENEFITS
- HIGH GRADE LIMITATIONS RESTRICT RECRUITING OF VERY EXPERIENCED AND QUALIFIED PERSONNEL
- CIVIL SERVICE BENEFITS, IMAGE, AND BUREAUCRATIC CONSTRAINTS ADVERSELY IMPACT RETENTION AND RECRUITING OF HIGH QUALITY INDIVIDUALS
- CURRENT RECESSION HAS AIDED QUALITY PERSONNEL RECRUITMENT. CONCERN EXISTS WHEN BUSINESS ACTIVITY IMPROVES
- SUCCESS IN OBTAINING HIGH QUALITY PERSONNEL RESULTS FROM EXTENSIVE RECRUITING, MATCHING OF TECHNICAL INTERESTS WITH OPPORTUNITIES, GEOGRAPHIC LOCATION AND ACADEMIC LINKAGES
- 18% OF LAB DIRECTORS PROJECT FUTURE DIFFICULTY IN MAINTAINING HIGH QUALITY WORK FORCE

CHART 60

Shown on this chart are the recruiting and retention programs that the laboratory directors found most effective. (Note that there are several duplications.) It appears that those programs which involve work at the laboratory before accession are most influential in recruiting and retention.

EFFECTIVE RECRUITING & RETENTION PROGRAMS

STRONGEST RECRUITING PROGRAMS REPORTED (IN DECREASING IMPORTANCE)

- STUDENT COOP
- FEDERAL JUNIOR FELLOWSHIP
- STUDENT VOLUNTEER/TRAINEE
- ACCELERATED PROMOTIONS
- INTERNS
- COLLEGE ON-SITE RECRUITING

STRONGEST RETENTION PROGRAMS REPORTED (IN DECREASING IMPORTANCE)

- STUDENT COOP
- INTERNS
- ACCELERATED PROMOTIONS
- GRADUATE PROGRAMS
- FEDERAL JUNIOR FELLOWSHIPS
- MINORITY PROGRAMS

CHART 61

This chart lists the factors that enhance recruitment and retention. First among these is the nature of the work engaged in by the laboratories. Associated with this factor are up-to-date equipment and modern facilities, and the excellent reputation that an organization may possess. This is followed by the nearness of the universities and the concomitant opportunities for continuing education and recruitment

FACTORS THAT ENHANCE RECRUITMENT AND RETENTION

- NATURE OF WORK ENGAGED IN BY LABS
- UP-TO-DATE EQUIPMENT AND MODERN FACILITIES
- POSITIVE REPUTATION OF AN ORGANIZATION
- PROXIMITY TO UNIVERSITIES
- OPPORTUNITIES FOR CONTINUING EDUCATION

CHART 62

The government can offer an outstanding bachelors degree holder $20,700 as an annual salary, while reports of offers by industry of $25,000 are common. The lack of promotion opportunities are perceived to be a significant factor in recruitment and retention of S&E.

Finally, there are two items particular to government service. Over the past years the image of the civil service has deteriorated. This is coupled with bureaucratic constraints with which we are all familiar. These two factors significantly reduce the quality of work life experienced by our scientists and engineers.

FACTORS THAT WEAKEN RECRUITMENT AND RETENTION

- Entry level salaries
- Lack of promotion opportunities
- Location
  - -- Housing
  - -- High cost of living
  - -- Remoteness from universities
  - -- Lack of public transportation
  - -- Commuting distances
  - -- Competing industries and government agencies nearby
- Adverse image of Civil Service
- Bureaucratic constraints

CHART 63

The vacancy rate for civilian S&E personnel is shown for each service and for the overall laboratory community. An overall rate of 5% is shown, however, the Army has a vacancy rate about twice that of the other services. Of the 19 laboratories having a vacancy rate over 10%, 16 are Army labs. Ten of the 19 are medical or human resources labs. Five of the 19 labs have vacancy rates ranging from 20% to 23%. No labs exceed this vacancy rate. The 19 labs and their vacancy rates are as follows:

Army Signals Warfare Laboratory, Warrenton, VA	23
Harry Diamond Laboratory, Adelphi, MD	23
Naval Health Research Center, San Diego, CA	21
Army Medical Bioengineering Laboratory, Frederick MD	20
Army Institute of Dental Research, Washington, DC	20
Army Aeromedical Research Laboratory, Fort Rucker, AL	17
Army Research Institute, Alexandria, VA	17
Walter Reed Army Institute of Research, Washington, DC	15
Mobility Equipment R&D Command, Fort Belvoi , MD	14
Army Research & Technology Laboratories, Moffett Field, CA	12
Air Force Weapons Laboratory, Kirtland AFB, NM	12
Army Institute of Surgical Research, Fort Rucker, AL	12
Army Avionics R&D Activity, Fort Monmouth, NJ	12
Army Human Engineering Laboratory, Aberdeen Proving Ground, MD	11
Army Combat Surveillance & Target Acquisition Laboratory, Fort Mormouth, NJ	11
Army Engineer Topographic Laboratories, Fort Belvoir, VA	11
Naval Medical Research Institute, Bethesda, MD	10
Army Research Institute of Environmental Medicine, Natick, MD	10

These labs constitute less than 11% of the total civilian S&E population.

The chart also provides data on military S&E vacancy rates by service across all DOD Laboratories. The overall average is 17%. The Air Force has the lowest rate; however, because of the substantial Air Force military S&E population, this represents a sizable shortage.

DOD LABORATORY S&E VACANCIES

(SEPTEMBER 30, 1981)

	ARMY	NAVY	AIR FORCE	TOTAL
PERCENT CIVILIAN VACANCIES	8	3	4	5
NUMBER OF LABORATORIES WITH				
10% OR GREATER CIVILIAN VACANCIES	16	2	1	19
MEDICAL AND HUMAN RESOURCES	8	2	0	10
20% OR GREATER CIVILIAN VACANCIES	4	1	0	5
MEDICAL AND HUMAN RESOURCES	2	1	0	3
PERCENT MILITARY VACANCIES	19	15	13	17

CHART 64

Over half the labs in the D.C. area have greater than a 10% vacancy rate, while in the other geographic areas the fraction is much smaller. Reasons for this may include the high cost of living and the easy mobility to many other federal jobs.

DOD LABORATORY CIVILIAN VACANCIES BY LOCATION

(SEPTEMBER 30, 1981)

LOCATION	NUMBER OF LABS	NUMBER OF LABS WITH MORE THAN 10% VACANCIES
DC METROPOLITAN AREA	12	7
NORTHEAST (MA, NH, RI, NY)	10	1
MIDATLANTIC (NJ, PA, MD, VA)	18	6
SOUTH (FL, AL, MS, LA)	10	2
MIDWEST (OH, IL, MI, CO)	7	0
WEST (TX, NM, CA)	14	5

CHART 65

Bureaucratic constraints evoked overwhelming negative reaction in questionnaires and briefings. The chart provides a partial list of some of these problem areas. The first group is personnel practices, where excessive paperwork is felt to be a significant impediment to proper functioning of the system. This is epitomized by the merit pay system, which was universally perceived as overly burdensome and which if it can not be repaired should be dismantled. Another result of excessive paperwork, as well as unreasonably long approval chains, is the fact that vacancies take much too long to fill. This will be discussed in the next chart in greater detail.

In the area of procurement practices, the great concern was that it took much too long to procure anything, from laboratory supplies to major contracts. In addition, the regulations limit the flexibility of all laboratory personnel in accomplishing their duties

The third major category of bureaucratic constraints is travel regulations, where restrictions appear to be applied without regard for the mission of the laboratory. In addition, many of the travel procedures are arbitrary and demeaning. Several other items were also cited as shown.

BUREAUCRATIC CONSTRAINTS

QUESTIONNAIRES AND INTERVIEWS SHOWED OVERWHELMING NEGATIVE REACTION

- PERSONNEL PRACTICES
  - EXCESSIVE PAPERWORK AND POSITION CLASSIFICATION DELAYS
  - MERIT PAY SYSTEM OVERLY BURDENSOME
  - VACANCIES TAKE TOO LONG TO FILL
- PROCUREMENT PRACTICES
  - INORDINATE DELAYS
  - LIMITED FLEXIBILITY
- TRAVEL
  - RESTRICTIONS APPLIED WITHOUT REGARD FOR MISSION
  - PROCEDURES ARBITRARY, DEMEANING
- OTHER
  - ADVERSE CIVIL SERVICE IMAGE
  - DELAYS IN OBTAINING CLEARANCES
  - EXCESSIVE AUDITS AND INVESTIGATIONS

CHART 66

This chart is a compilation of data on the length of time it takes to recruit various levels of personnel. The recruiting chain is started when a decision is made formally that a new person is required. The time from that decision to formal advertisement of the position is the time noted as prior to advertisement. Advertisement to review spans the time from the publishing of the advertisement to the beginning of the review process when applications have been filed. The review process spans the next period of time, followed by the approval process, and finally the time between approval and reporting. There are some interesting differences among the services in this chart. At the entry level the Air Force, on average, is the quickest, taking slightly over two months to acquire a GS-5 or GS-7, while the Army takes nine months. At the GS-9 to GS-12 level, the Air Force is still the fastest, and the Army has speeded up its process. The Navy can recruit in just under four months, while it takes the Army and Air Force something over five months to acquire a GS-13 to GS-15. Finally, at the senior executive level the Navy is still the fastest, taking over six months, while it takes the Army and the Air Force about a year and a half to accomplish the same action. Clearly there are different procedures and different approval chains to contend with. These times confirm the earlier complaint that personnel actions take far too long.

TIME TO RECRUIT

(DAYS, AS OF 30 SEPTEMBER 1981)

Recruitment Steps	GS 5-7				GS 9-12			
	ARMY	NAVY	AF	AGGREGATE	ARMY	NAVY	AF	AGGREGATE
Prior to Adv.	54	19	14	33	38	24	18	30
Adv. to Review	55	18	9	32	40	29	23	33
Review to Select	44	40	13	36	19	19	13	18
Approval	36	1	1	16	11	10	2	9
Reporting	82	16	29	47	36	15	27	27
Total Time	271	94	66	164	144	97	83	117

	GS 13-15				SES/PL/GS 16-18			
	ARMY	NAVY	AF	AGGREGATE	ARMY	NAVY	AF	AGGREGATE
Prior to Adv.	35	16	20	24	163	41	85	79
Adv. to Review	43	38	67	47	40	66	79	62
Review to Select	28	28	37	30	20	34	139	48
Approval	35	1	9	16	310	34	199	130
Reporting	30	30	30	30	19	31	43	30
Total Time	171	113	163	147	552	206	545	349

CHART 67

This chart shows the percentage of recruiting actions accomplished by various groups in the laboratory community. The civilian personnel office and technical management each account for about one-third of the personnel recruitments with the civilian personnel office recruiting slightly more at the entry level, and technical management recruiting more journeymen. In the Navy most of the recruiting is done by technical management. In the Army and Air Force the civilian personnel office recruits more entry level personnel, while technical management recruits more journeymen.

RECRUITERS

(PERCENT OF RECRUITING BY VARIOUS PERSONNEL, 1981)

	Entry Level Hires				Journeymen Hires			
	ARMY	NAVY	AF	AGGREGATE	ARMY	NAVY	AF	AGGREGATE
Senior Mgt.	19	10	6	13	23	11	24	19
Civ. Pers. Office	39	19	46	33	29	34	30	31
Technical Mgt.	20	40	30	30	35	42	29	36
Journeyman S&E	20	31	18	24	12	14	17	13

CHART 68

Collected here is information that was gathered on the dual-career ladder, the ability of a scientist or engineer to advance in a technical career path as opposed to a managerial or supervisory career path. Thirty percent of the laboratories reported that a dual-career objective existed. While the questionnaire did not explicitly address the dual-career ladder, many comments were received as shown that raise concern over the success of this program.

DUAL CAREER LADDER

- CURRENT LEGISLATION AND PROCEDURES PROVIDE FOR DUAL-CAREER LADDER OF TECHNICAL VS MANAGERIAL/SUPERVISORY POSITIONS
- 30% OF LABS REPORTED THAT A DUAL-CAREER OBJECTIVE WAS THE PRIMARY CRITERION FOR PROMOTING NON-SUPERVISORY PERSONNEL
- QUESTIONNAIRE DID NOT EXPLICITLY ADDRESS SUCCESS OF A DUAL-CAREER LADDER. HOWEVER, MANY LABS COMMENTED ON ISSUE:
  - ALMOST ALL AIR FORCE LABS REPORTED USING A DUAL-CAREER LADDER
  - SOME LABS REPORTED THAT EXTENSIVE JUSTIFICATION WAS REQUIRED TO PROMOTE AN INDIVIDUAL TO A NON-SUPERVISORY HIGH-GRADE
  - SOME LABS REPORTED THAT THEY HAD LIMITED ADVANCEMENT OPPORTUNITIES FOR DUAL-LADDER PROMOTIONS, THAT SUPERVISORY POSITIONS HAD FIRST PRIORITY AND THAT HIGH-GRADE LIMITATIONS PRECLUDED FULL USE OF DUAL-CAREER LADDER
  - SOME LABS STATED THAT GS-14'S AND ABOVE ALL REQUIRED SUPERVISORY RESPONSIBILITIES
- SUFFICIENT COMMENTS WERE MADE REGARDING HIGH-GRADE CEILINGS, NON-SUPERVISORY PROMOTIONS AND DUAL-CAREER LADDER TO RAISE CONCERN OVER SUCCESS OF THIS PROGRAM

CHART 69

This chart summarizes the information on recruiting that is shown in the preceding section. In spite of the salary differential, it is clearly possible to recruit high quality personnel at the GS-5 to GS-7 level. Recruiting takes an excessively long time in most labs. The methods for achieving relatively fast turnaround on recruiting personnel actions apparently are not shared. Two important items limiting our ability to recruit are the adverse Civil Service image, and the bureaucratic constraints experienced by the work force. The questionnaire indicates that although the labs are able to acquire satisfactory personnel, the recruiting methods need to be improved. The work experience programs appear to be the most effective, both for acquiring new recruits and for ensuring that they are retained once hired. Finally, it is exceptionally difficult to hire high quality journeymen.

SUMMARY: RECRUITMENT AND RETENTION

RECRUITING:

- SUCCESSFUL RECRUITMENT AT ENTRY LEVEL (GS-5/7) IN SPITE OF SALARY DIFFERENTIAL
- EXCESSIVELY LONG HIRING PROCESS FOR MOST LABS
  - SUCCESSFUL PROCEDURES ARE NOT NECESSARILY SHARED
- ADVERSE CIVIL SERVICE IMAGE AND BUREAUCRATIC CONSTRAINTS EVIDENT
- QUESTIONNAIRES INDICATE:
  - MAJORITY OF LABS REPORT QUALITY OF NEW HIRES SAME OR BETTER THAN 5 YEARS AGO
  - RECRUITING METHODS NEED TO BE IMPROVED
  - WORK EXPERIENCE PROGRAMS APPEAR TO BE MOST EFFECTIVE FOR ENTRY LEVEL
  - DIFFICULT TO HIRE HIGH QUALITY JOURNEYMAN PERSONNEL

CHART 70

This chart summarizes our findings on retention. The vacancies at the upper end of the laboratory work force are largely filled by promotions. While most of the losses suffered by the laboratories are at the GS-12 to GS-13 level, these losses represent only a small fraction of the total GS-12 and GS-13 populations. Thus, it appears that overall attrition is not a problem; however, vacancy rates of 19 labs are 10% or larger and vacancy rates of military S&E average 17%. The last item on the chart lists a number of subjective conclusions drawn from questionnaire data.

SUMMARY: RECRUITMENT AND RETENTION

RETENTION

- 84% HIGH-GRADE VACANCIES FILLED BY PROMOTION
  - ANNUAL PROMOTION RATE 5-7%
- LARGE NUMERICAL LOSSES OCCUR AT GS-12/13 LEVEL (58% OF DEPARTURES), ALTHOUGH ONLY REPRESENTING APPROXIMATELY 6% OF THIS INVENTORY
- ATTRITION RATE NOT A PROBLEM AT ANY GRADE LEVEL
- CIVILIAN VACANCY RATES AT 19 LABS WITH LESS THAN 11% OF S&E ARE 10% OR LARGER; MILITARY S&E VACANCY RATES AVERAGE 17%
- QUESTIONNAIRES INDICATE:
  - AMONG GS-12/13 LEAVING IS A SMALL CORE OF HIGHLY QUALIFIED PERSONNEL
  - RELIEF FROM HIGH-GRADE CONSTRAINTS DESIRED
  - LACK OF COMPREHENSIVE CONTINUING EDUCATION
  - LACK OF EFFECTIVE DUAL-CAREER LADDER
  - MAJOR REACTIONS TO BUREAUCRATIC CONSTRAINTS AND ADVERSE IMAGE OF CIVIL SERVICE
  - QUALITY OF WORK FORCE GOOD TO EXCELLENT
  - CURRENCY OF WORK FORCE ADEQUATE TO GOOD
  - FUTURE HIGH QUALITY WORK FORCE WILL BE HARDER TO RETAIN
  - WORK EXPERIENCE PROGRAMS APPEAR TO BE MOST EFFECTIVE

CHART 71

Because training is an important component of the laboratory retention program, we have separated the information on training into a single section. We review policies and participation.

VII. TRAINING

VII

VII. TRAINING

CHART 72

The law and regulations governing training within the laboratories allow wide flexibility. None of the limitations in these laws and regulations are presently difficult to accommodate. There appeared to be wide variation in the care with which laboratories forecast their needs and plan their training programs.

TRAINING POLICIES

- WIDE FLEXIBILITY ALLOWED WITHIN LAW AND REGULATIONS
  - LIMITATIONS EXIST
    - DEGREE AS A PRIMARY OUTCOME
    - 1 IN 10 YEAR TRAINING LIMIT
    - 1% OF AGENCY MANPOWER CONSTRAINT ON LONG-TERM TRAINING
- A FEW LABS REPORT CAREFUL PLANNING, INCLUDING USE OF CAREER DEVELOPMENT OR OTHER FORMAL REVIEW COMMITTEES

CHART 73

This chart shows the short-term training activity reported in the questionnaire. There was a wide variety of training courses reported, with participation rates varying significantly among the laboratories. No laboratory reported problems in accomplishment of necessary training.

TRAINING PARTICIPATION
(1981)

- WIDE VARIETY OF SHORT-LENGTH PROGRAMS USED (LESS THAN 120 DAYS)
  - PARTICIPATION RATES VARY AMONG LABS

	S&E PARTICIPATION RANGE	
TRAINING TYPE	LOWEST LAB USAGE	HIGHEST LAB USAGE
TECHNICAL TRAINING	25%	50%
SYMPOSIA AND SEMINARS	50%	75%
SUPERVISORY/MANAGEMENT	10%	25%
CONTINUING EDUCATION	10%	25%

  - SOURCES INCLUDE IN-HOUSE, UNIVERSITY, CONTRACT, OTHER GOVERNMENT

- NO REPORTS OF PROBLEMS
  - INTERVIEWS AND QUESTIONNAIRES REFLECT POSITIVE ATTITUDE TOWARD TRAINING PROGRAMS AND THEIR CONTRIBUTIONS TO MISSIONS, RECRUITMENT AND RETENTION

CHART 74

Long-term training was cited as a valuable method for developing skills and attracting and retaining S&E work force. Only 22 laboratories reported its use during the last five years.

LONG-TERM TRAINING
(OVER 120 DAYS DURATION)

- CITED AS A VALUABLE METHOD TO DEVELOP SKILLS, ATTRACT AND RETAIN RECRUITS
- 22 OF 71 LABS REPORTED USE DURING THE PAST FIVE YEARS
  - OF THOSE REPORTING, 1% - 3% OF THE S&E WORK FORCE PARTICIPATED

CHART 75

Cooperative education is a proven work experience program for meeting critical needs and enhancing recruitment and retention. Thirty-six laboratories reported active programs.

COOPERATIVE EDUCATION
(SEPTEMBER 30, 1981)

- COOP EDUCATION PROGRAMS ACTIVE AT 36 LABS

	ARMY	NAVY	AF	TOTAL
— NUMBER OF PARTICIPATING LABS	19	11	6	36
— NUMBER OF COOP STUDENTS	306	428	95	829
— ESTIMATED CONVERSION RATE	39%	38%	26%	34% (AVG.)
— RETENTION RATE BEYOND 3 YRS.	—	—	—	66% (AVG.)

- LITTLE APPARENT USE MADE OF GOVERNMENT FUNDING OF TUITION

CHART 76

Overall the study finds that training policies are broad and flexible, allowing wide latitude in meeting needs. Active training programs have been established. They are well received as reported in interviews, discussions and questionnaires, and make a valid and worthwhile contribution to lab missions. Cooperative education and long-term training programs have not been fully exploited by some labs and can be expanded.

SUMMARY: TRAINING

- TRAINING POLICIES ALLOW WIDE LATITUDE
- ACTIVE TRAINING PROGRAMS ARE A VALUABLE TECHNIQUE TO MAINTAIN STATE-OF-THE-ART COMPETENCY
- ACTIVE TRAINING PROGRAMS HAVE BEEN ESTABLISHED AND ARE WELL RECEIVED, CONCENTRATING ON SHORT AND MODERATE TERM COURSES
- LONG TERM TRAINING AND COOP EDUCATION PROGRAMS CAN BE SIGNIFICANTLY EXPANDED

SUMMARY: TRAINING

- Training policies allow wide latitude
- Active training programs are a valuable technique to maintain state-of-the-art competency
- Active training programs have been established and are well received, concentrating on short and moderate term courses
- Long term training and coop education programs can be significantly expanded

CHART 77

In this section we provide data on senior executives and technicians. The primary focus on this study was on the main body of S&E personnel. Accordingly, the small group of senior executives within that work force were not singled out for special study. The technician work force has significant numbers of personnel as we have shown earlier. A large amount of data on technicians was obtained through both the laboratory questionnaire and the Defense Manpower Data Center. These data are summarized briefly in this section, and the remainder are provided for futher reference in the appendix to this report. Because of the shortness of the section, a summary was not provided at the end.

VIII. ADDITIONAL TOPICS

VIII

VIII. ADDITIONAL TOPICS

CHART 78

Senior executives account for approximately one percent of the civilian scientists and engineers. The Army and Navy have larger numbers of senior executives; however, the ratios of senior executives to total S&E population are comparable. There is a relatively high vacancy rate, 23%, in senior executive positions. The Navy is lowest at 13% while the Air Force is highest at 42%. Other significant problems relating to senior executives are the long time to recruit them, the pay cap, and their relative immobility because of the high cost of relocation to the individual.

SENIOR EXECUTIVES

- ON-BOARD DISTRIBUTION BY TYPE:

YEAR	GS 16-18	PL 313	SES	TOTAL
1977	87	120	--	207
1981	12	6	177	195

- DISTRIBUTION BY SERVICE FOR 1981:

	ARMY	NAVY	AIR FORCE	TOTAL
SENIOR EXECUTIVES ON BOARD	61	109	25	195
VACANCIES	24	16	18	58
SENIOR EXECUTIVE POSITIONS AS PERCENT OF S&E	1.0	1.1	1.0	1.1
PERCENT VACANCIES	28	13	42	23

- LENGTH OF TIME TO RECRUIT (DAYS):

ARMY	NAVY	AIR FORCE
522	206	544

- PAY CAP CITED BY LAB DIRECTORS AS A PROBLEM IN RECRUITING AND RETENTION
- RELATIVE IMMOBILITY DUE TO HIGH COST OF RELOCATION TO INDIVIDUAL

CHART 79

This chart and the next two charts discuss technicians in the laboratories. In the Army and Navy essentially, all the technicians are civilian, while about 60 percent of the Air Force technicians are military. The ratio of the number of technicians to the number of scientists and engineers within the services is essentially constant and approximately 30 percent.

CIVILIAN AND MILITARY TECHNICIAN WORK FORCE

(SEPTEMBER 30, 1981)

	ARMY	NAVY	AIR FORCE	TOTAL
CIVILIAN TECHNICIANS	2,342	2,904	495	5,741
MILITARY TECHNICIANS	*	*	753	753
TOTAL TECHNICIANS	2,342	2,904	1,248	6,494
TOTAL S&E	8,393	10,967	4,328	23,686
TECHNICIANS AS A PERCENT OF S&E	28	26	29	27

*NEGLIGIBLE

CHART 80

This chart shows pertinent statistics on technicians.

CIVILIAN TECHNICIAN STATISTICS

- 83% of civilian technicians are engineering technicians — comparable fraction in each service
- 10% reduction in civilian technicians since 1977
- GS 9-14 technicians decreased while GS 1-8 technicians increased (1977-1981)
  - — average grade has dropped from 9.3 to 8.8
- Average length of service decreased from 20.2 years in 1978 (a peak year) to 19.0 years in 1981
- Average age has remained slightly above 45
- Overall turnover rate of technicians is relatively level at 9%
  - — Air Force rate is up from 7.5% in 1977 to 14% in 1981
  - — Army and Navy rates are marginally down
- Most separations are due to retirement — 50% (down from 65% in 1980) and resignations — 32% (up from 22% in 1980)

CHART 81

This chart summarizes the comments made by laboratory directors about technicians. The laboratories are managing in the face of some recruiting difficulties. As a rule, laboratory directors would prefer to have a scientist or an engineer rather than a technician. Some technician functions are being contracted out. Concern was expressed over the ability to find qualified young replacements. Consequently, some laboratories are initiating apprentice programs or making arrangements with local colleges.

LABORATORY TECHNICIANS

LABORATORY DIRECTORS REPORT:

- RECRUITING, ALTHOUGH DIFFICULT, IS BEING ACCOMPLISHED
- MANAGERS HAVE TO CHOOSE BETWEEN S&E AND TECHNICIANS WHEN HIRING
- SOME TECHNICIAN FUNCTIONS HAVE BEEN CONTRACTED OUT
- CONCERN EXISTS OVER FINDING QUALIFIED YOUNG REPLACEMENTS
- SOME LABS HAVE OR ARE INITIATING APPRENTICE PROGRAMS
- SOME LABS ARE MAKING ARRANGEMENTS WITH LOCAL COLLEGES TO TRAIN TECHNICIANS
- FUTURE REQUIREMENTS REFLECT MODEST INCREASES IN ELECTRICAL, ENGINEERING, AND BIOLOGICAL TECHNICIANS

CHART 82

The following three charts summarize the major findings of this study.

IX. MAJOR FINDINGS

IX. MAJOR FINDINGS

CHART 83

This chart and the following two provide a summary of principal findings and conclusions of this study. In assessing the status of scientists and engineers in the approximately 70 defense labs, it is clear that the three separate service lab systems have separate and unique characteristics. Likewise there are differences among individual service labs. The study has elucidated the variations in type of work, the uses of S&E personnel, the variation in numbers of military S&E, and many other distinct characteristics. In general, over the period 1977 to 1981, the lab S&E work force has remained relatively stable; and within a few percent, the total lab population, the S&E population, the S&E educational levels, and S&E grade levels have all remained constant. Navy total population and high grades have continued a decline of 1-2% per year. Only the entry level S&E have increased over the 1977-81 time frame. At the same time, data available to this study indicate that the S&E work force has maintained generally good quality and currency. We have examined attrition from the S&E population by grade level and find the departure rates to be reasonable. Because of the substantial populations of GS-12 and GS-13, the majority of attrition occurs at these levels. As a result there are significant losses at these critical levels which are hard to replace There appears to be concern about the relatively slow promotion rate, especially at the higher grade levels, but this is the price paid for a stable work force. As we compared the DOD lab S&E population to nongovernmental S&E populations, the labs show approximately similar educational distribution as compared to the national S&E population, but the labs not unexpectedly have a somewhat skewed distribution of disciplines in favor of the engineering and high technology skills. We have noted comparatively few computer scientists in the DOD lab work force. The "computer scientist" job series does not properly account for the total computer professionals within the DOD laboratories. Many are subsumed for example under engineering job series titles. The lab S&E work force is approximately five years older on average than the national S&E population; over the last three years, the average lab S&E age has remained relatively constant. In spite of special entry salaries for DOD lab engineers, there is a substantial shortfall within DOD labs compared to industry. This trend reverses past age 43, with the labs on average ahead. If industry salaries are compared to those at DOD labs at equal levels of responsibility, laboratory salaries lag at all grade levels. Also DOD S&E have suffered a higher relative decline in salary due to inflationary effects.

SUMMARY: MAJOR FINDINGS

- CONSIDERABLE VARIATION AMONG SERVICE LABS
- OVERALL STABLE LAB WORK FORCE (1977-81)
  - TOTAL LAB POPULATION
  - S&E POPULATION, EDUCATIONAL LEVELS, GRADE LEVELS
  - AVERAGE ATTRITION RATE NOT A PROBLEM AT ANY GRADE
    - LARGE GS-12 & GS-13 LOSSES DUE TO LARGE POPULATIONS; SMALL CORE OF SIGNIFICANT LOSSES HARD TO REPLACE
  - LIMITED PROMOTION RATE, PRICE FOR STABLE WORK FORCE
- QUALITY OF ENTRY S&E AND OVERALL S&E CURRENCY ARE REPORTED AS GOOD
- LAB S&E COMPARED TO NONGOVERNMENTAL S&E SHOW:
  - EDUCATION SIMILAR BUT DISCIPLINES DIFFER FROM NATIONAL AVERAGES
    - VERY FEW LAB COMPUTER SCIENTISTS IDENTIFIED
  - AVERAGE AGE 5 YEARS HIGHER
  - ENTRY SALARIES SIGNIFICANTLY BELOW INDUSTRY
  - AVERAGE SALARIES ABOVE INDUSTRY OVER AGE 43
  - AVERAGE SALARIES LOWER FOR EQUAL RESPONSIBILITY
  - GREATER INFLATIONARY EFFECT ON SALARY

CHART 84

Our findings show some selected skill shortages in the DOD lab work force. These shortages are mostly well within the annual attrition rates, and as such do not raise any special alarms of major impending problems. In the context of predicted national shortages, it is thus mandatory that the DOD lab community maintain a watchful eye on the status of its ability to recruit and retain a quality S&E work force. There is nothing in this study to date that indicates that a major problem exists or is developing in the DOD lab community. Perhaps the first pressure point may be difficulty in maintaining the lab Ph.D. or Masters populations owing to the decline of U.S. citizen graduates in these categories. Another area of some concern is computer professionals considering the strong projections of shortages coupled with the laboratory projections for enhanced activity in information-related technologies. The problem is exacerbated in that there is no definitive assessment of computer professionals through the normal job series categorization. One avenue available to the labs to deal with shortages are the excellent training programs extant in DOD. Our study has found that long-term training could be greatly expanded to address shortages as they become apparent, as well as to enhance the currency of the technical work force. This approach appears superior to having the labs sponsor national level programs in that they are less than one percent of the national S&E work force. One additional basis for a conservative approach at the present time derives from the uncertainty of future S&E national shortages, since such shortages are very closely linked to the future economic picture, a subject of much speculation and unpredictability. The study panel believes that there are a great variety of improvements which could be made to enhance the DOD Labs S&E recruitment and retention posture and these are quite exclusive of shortages.

The DOD labs have reported significant adverse impact of the controls on personnel ceilings and high grades. Overall personnel ceilings are a reality requiring continued management attention. As such, some fairly difficult management choices have to be made. Ceilings by themselves are not an intrinsic barrier to maintenance of an effective S&E work force beyond a critical mass required to operate a laboratory. What does appear to be important is the maintenance of a stable ceiling consistent with workload to facilitate planning and management within the DOD labs. On the matter of high grade controls for GS-13 to GS-15, the study findings indicate that overall numbers approach 50% of the S&E population; however, wide variations exist among labs and services. An analysis of laboratory workload has not been undertaken in connection with this study. Judgments on the adequacy of ceilings, both total personnel and high grades can therefore not be made based on the quantitative data collected. The majority of Technical Directors did report significant adverse impact of high grades and total ceilings including reduced ability to meet mission requirements, deletion of specific technologies that should be addressed, reduced ability to hire and promote experienced and deserving personnel as well as overall reduced quality of work.

SUMMARY: MAJOR FINDINGS, Cont.

- INDICATIONS OF SOME SELECTIVE SKILL SHORTAGES IN DOD LAB WORK FORCE
  - SMALL PERCENTAGE, LESS THAN ANNUAL ATTRITION RATE
- PREDICTED NATIONAL SHORTAGES MAY MATERIALIZE; PRUDENT POSTURE REQUIRED
  - PARTICULAR PRESSURE POINT MAY BE PH.D. RECRUITMENT IN FUTURE
  - DOD TRAINING PROGRAMS COULD PROVIDE EXCELLENT HEDGE AGAINST SHORTAGES
- DOD LAB S&E POPULATION TOO SMALL TO BE NATIONAL DRIVER
- RECRUITMENT AND RETENTION PROBLEMS EXIST IN DOD LABS EXCLUSIVE OF NATIONAL SHORTAGES; SHORTAGES WILL GREATLY EXACERBATE PROBLEM
- DIRECTORS REPORT SIGNIFICANT ADVERSE IMPACT OF TOTAL PERSONNEL CEILING AND HIGH-GRADE CONTROL
  - CEILINGS IMPOSE SIGNIFICANT CONSTRAINTS THAT MUST BE OBSERVED AND MANAGED
  - OVERALL DOD LAB HIGH-GRADE TOTALS APPROACH 50% OF S&E; HOWEVER, WIDE VARIATIONS EXIST AMONG LABS AND SERVICES

CHART 85

There are a number of areas where problems exist and directed action is needed. Maintenance of the currency of the technical work forces is mandatory in light of the rapid rate of technological progress. A comprehensive approach to continuing education is needed. Recruitment at the key journeyman levels, GS-12 and GS-13, will require special attention, particularly due to the relatively low promotion opportunities. The study has developed data that clearly show that a special effort is required to reduce the number of senior executive vacancies. Furthermore, management attention is indicated in addressing relatively high civilian vacancy rates which exist at certain laboratories and in the military S&E assigned to the laboratories. The subject of bureaucratic constraints has been amply addressed in other studies as well as here. Clearly forthright and forceful actions are required to turn the clock back on many of these impediments both to recruitment and retention as well as to improved efficiency and productivity within the DOD labs. We have shown in this study, for example, the absurd time delays that encumber the hiring process. An improvement in this one area would go far beyond any problems which now exist as a derivative of national shortages. The high vacancy rates for senior executives, for example, are undoubtedly related to the long and tedious process for recruitment. If the DOD labs are to attract and retain quality people, the image of the federal worker cannot continue to be diminished. There must be a renewed awareness of the destructiveness of the process which denigrates a work force which is so critical to national security. The study has found that there is a general allegiance to the dual-career concept of professional advancement through scientific and engineering pursuits as well as through management avenues; however, there is much room for improvement in practice to achieve a truly dual path to the most senior grade levels. Finally, the study in a number of instances has found a fairly wide gulf between perceptions about the DOD lab S&E work force and quantitative data which provides specific information on the overall status of the lab S&E. Chief among these were an inability to recruit at the entry level, declining quality, and unhealthy attrition levels. There are, of course, variations over the DOD labs as we have pointed out earlier, and accordingly each laboratory must take a close look at its circumstances in light of the overall lab environment.

SUMMARY: MAJOR FINDINGS, CONT.

- PROBLEMS DO EXIST AND NEED ATTENTION, SUCH AS
  - COMPREHENSIVE CONTINUING EDUCATION
  - RECRUITMENT AT JOURNEYMEN LEVEL
  - LARGE NUMBER OF SENIOR EXECUTIVE VACANCIES
  - SOME LABS EXPERIENCING CIVILIAN S&E VACANCIES OF 10% OR LARGER; MILITARY S&E VACANCY RATES AVERAGE 17%
  - QUANTITATIVE ANALYSIS OF HIGH-GRADE ADEQUACY
  - BUREAUCRATIC CONSTRAINTS (E.G., EXCESSIVELY LONG PROCESS TO HIRE)
  - IMAGE OF FEDERAL WORKER
  - EFFECTIVE USE OF DUAL-CAREER PATH
  - PERCEPTIONS NOT GENERALLY SUPPORTED BY DATA ALTHOUGH EXCEPTIONS EXIST
    - INABILITY TO RECRUIT AT ENTRY LEVEL
    - DECLINING QUALITY
    - UNHEALTHY ATTRITION LEVELS

CHART 86

The following charts list the recommendations that arise from this study.

X. RECOMMENDATIONS

X. RECOMMENDATIONS

FRAMEWORK FOR RECOMMENDATIONS

- THE SERVICES AND THEIR LABORATORY COMMUNITIES SHOULD DEVELOP AN INTEGRATED PROGRAM, WHICH INCLUDES:
  - A MEANS FOR FORECASTING S&E PERSONNEL NEEDS
  - A COMMON DATA BASE FOR IDENTIFYING S&E CANDIDATES
  - A WELL-CONCEPTUALIZED AND INTERRELATED RECRUITMENT AND RETENTION PROGRAM UTILIZING TO THE FULLEST EXTENT POSSIBLE WORK EXPERIENCE, CONTINUING EDUCATION AND CAREER DEVELOPMENT PROGRAMS SHOWN TO BE MOST EFFECTIVE FOR RECRUITMENT AND RETENTION
  - A CONCERTED EFFORT TO IMPROVE THE IMAGE OF THE FEDERAL SERVICE AND TO REDUCE BUREAUCRATIC CONSTRAINTS NOW HAMPERING LABORATORY PRODUCTIVITY

- THE SERVICES AND LABORATORY COMMUNITIES SHOULD BE ENCOURAGED TO EMPHASIZE SOME ELEMENTS MORE THAN OTHERS DEPENDING ON THE UNIQUE NEEDS AND RESOURCES OF EACH SERVICE, AND TO SHARE EXPERIENCES/SUCCESSES/FAILURES WITH EACH OTHER

- OSD SHOULD FACILITATE THE SERVICE'S EFFORTS IN IMPLEMENTING THE RECOMMENDATIONS OF THIS STUDY BY:
  - SUPPORTING THOSE AREAS WHERE CONGRESSIONAL, OSTP, OMB, OR OPM INTERCESSION IS REQUIRED (E.G., NON-COMPETITIVE ENTRY LEVEL SALARIES)
  - REDUCING BUREAUCRATIC CONSTRAINTS UNDER OSD CONTROL
  - COORDINATING WITH AND SUPPORTING PROGRAMS OF NSF WHICH CONTRIBUTE TO THE SCIENTIFIC AND ENGINEERING NEEDS OF THE DOD LABORATORIES

RECOMMENDATION: FORECAST S&E NEEDS

AN ANNUAL FORECAST SHOULD BE MAINTAINED OF PROJECTED LONG-TERM S&E NEEDS OF THE DOD LABS IN ANTICIPATION OF FUTURE SHORTFALLS. THIS FORECAST SHOULD SERVE AS A BASIS FOR DIRECTED RECRUITMENT AND TRAINING PROGRAMS. EACH OF THE SERVICE LAB MANAGEMENT OFFICES SHOULD MONITOR THE PROCESS SO THAT DATA ARE ASSEMBLED IN A COMMON FORMAT TO FACILITATE EXCHANGE OF INFORMATION AMONG SERVICES, AND TO TAKE CORRECTIVE ACTION AS MAY BE APPROPRIATE (E.G., MORE TIMELY ADJUSTMENT OF NON-COMPETITIVE SALARIES). IN PARTICULAR, HIGH PRIORITY SHOULD BE ACCORDED TO MONITORING THE STATUS OF COMPUTER PROFESSIONALS IN THE DOD LABORATORIES, AND TO TAKING AGGRESSIVE ACTION TO ADJUST COMPENSATIONS LEVELS AS NEEDED.

RECOMMENDATION: ESTABLISH RECRUITMENT DATA BASE

SERVICES SHOULD ESTABLISH COMPATIBLE DATA BASES TO ALLOW DOD LABS TO EXCHANGE INFORMATION ON S&E CANDIDATES AVAILABLE FOR EMPLOYMENT.

RECOMMENDATION: IMPROVE ENTRY-LEVEL AND JOURNEYMAN RECRUITMENT

- LABS SHOULD DEVELOP IMAGINATIVE ENTRY-LEVEL RECRUITING PROGRAMS THROUGH ACTIVE USE OF SPECIAL PROGRAMS & AUTHORITIES ALREADY AVAILABLE:
  - COOPERATIVE EDUCATION
  - SUMMER EMPLOYMENT OF STUDENTS
  - FEDERAL JUNIOR FELLOWSHIP PROGRAM
  - DOD SCIENCE & ENGINEERING APPRENTICESHIP PROGRAM
  - COLLEGE RELATIONSHIP EFFORTS
    - FORMAL & INFORMAL CONTACTS
    - RESEARCH & GRANT PROGRAMS
    - SEC. 6C3, TITLE VI, DOD AUTHORIZATION ACT OF 1982
    - FACULTY APPOINTMENTS
    - GRADUATE STUDENT APPOINTMENTS
    - STUDENT VOLUNTEER SERVICE
- LABORATORIES/SERVICES SHOULD DEVELOP A FOCUSED RECRUITING PROGRAM TO ATTRACT QUALIFIED JOURNEYMEN (GS 12-13) WITH SKILLS IN SHORTAGE AREAS
- SPECIAL EFFORT SHOULD BE MADE TO TARGET UNDER-REPRESENTED GROUPS, SUCH AS WOMEN
- OSD AND SERVICES SHOULD SUPPORT PROPOSED LEGISLATIVE INITIATIVE TO BROADEN APPLICATION OF THE NAVY PERSONNEL DEMOSTRATION PROJECT

RECOMMENDATION: ADDRESS SELECTED VACANCIES

MANAGEMENT ATTENTION IS NEEDED TO ADDRESS LARGE VACANCY RATES WHICH EXIST IN ALL SERVICE LABORATORIES IN THE SENIOR EXECUTIVE POSITIONS, IN THE CIVILIAN S&E WORK FORCE AT CERTAIN LABORATORIES (PREDOMINANTLY THE ARMY), AND IN MILITARY S&E ASSIGNED AT THE LABORATORIES.

RECOMMENDATION: ADDRESS S&E SHORTAGES THROUGH TRAINING ASSIGNMENTS

THE GOVERNMENT EMPLOYEES TRAINING ACT (1958) AND OTHER AUTHORITIES PROVIDE WIDE LATITUDE IN TRAINING OF PERSONNEL. ONE OF THESE MOST EFFECTIVE MEANS OF HANDLING S&E SHORTAGES IN CRITICAL DISCIPLINES IS THROUGH PLANNED TRAINING FOR SELECTED PERSONNEL. SERVICE LABORATORY MANAGEMENT SHOULD DESIGN AGGRESSIVE LONG-TERM TRAINING PROGRAMS TO DEVELOP EXPERIENCED S&E. BOTH FUNDS AND BILLETS SHOULD BE FENCED WITHIN THE SERVICES FOR THIS PURPOSE.

RECOMMENDATION: ADDRESS S&E SHORTAGES THROUGH UNIVERSITY FUNDED PROGRAMS

DOD TECHNOLOGY BASE FUNDING AT UNIVERSITIES SHOULD TAKE EXPLICIT ACCOUNT OF CURRENT AND PROJECTED SHORTAGES OF SPECIFIC S&E DISCIPLINES AT THE DOD LABORATORIES. THESE CONSIDERATIONS SHOULD IMPACT DECISIONS ON DOD SPONSORED UNIVERSITY FELLOWSHIP PROGRAMS AS WELL AS SPECIFIC CATEGORIES OF R&D FUNDED AT THE UNIVERSITIES. PROGRAMS WHICH EITHER ENCOURAGE DOD LABORATORY EMPLOYMENT OR REQUIRE A LABORATORY COMMITMENT AS THE QUID PRO QUO FOR UNIVERSITY SUPPORT SHOULD BE CONSIDERED EXPLICITLY BY CONSULTATION BETWEEN SERVICE TECHNOLOGY BASE MANAGERS AND SERVICE LABORATORY MANAGEMENT OFFICES.

RECOMMENDATION: IMPROVE DUAL CAREER PROGRAM

LABORATORY DIRECTORS SHOULD IMPLEMENT A REALISTIC DUAL- (SUPERVISORY/MANAGEMENT VS. RESEARCH) CAREER PATH AND APPORTION HIGH-GRADE BILLETS ACCORDINGLY. THIS MAY REQUIRE ORGANIZATIONAL CHANGES TO INCREASE SPAN OF CONTROL OF SUPERVISORS/MANAGERS AND ELIMINATE SMALL ORGANIZATIONAL ENTITIES CREATED PRIMARILY TO JUSTIFY HIGH-GRADE SUPERVISORY BILLETS.

RECOMMENDATION: IMPROVE IMAGE OF CIVIL SERVICE

DOD MANAGEMENT SHOULD ENHANCE RETENTION BY PROMOTING THE VALUE AND IMAGE OF FEDERAL EMPLOYMENT AT THE DOD LABS. MEASURES INCLUDE, BUT ARE NOT LIMITED TO, POLICIES FOR TREATMENT OF S&Es AS PROFESSIONALS, ACKNOWLEDGEMENT OF SIGNIFICANT WORK BY APPROPRIATE S&E RECOGNITION, AND SUITABLE ADVERTISEMENT OF LABORATORY CONTRIBUTIONS BOTH TO THE DEFENSE AND CIVIL SECTORS. AS A FURTHER POSITIVE CONTRIBUTION, MAXIMUM RESTRAINT SHOULD BE EXERCISED BY ALL OFFICIALS TO AVOID PEJORATIVE COMMENTS PERTAINING TO CIVIL SERVANTS AS A GROUP WHICH REFLECT BOTH UNFAIRLY AND INACCURATELY ON INDIVIDUALS WITHIN THE SERVICE.

RECOMMENDATION: REDUCE BUREAUCRATIC CONSTRAINTS

MANAGEMENT SHOULD SYSTEMATICALLY IDENTIFY BUREAUCRATIC CONSTRAINTS, AND SHOULD SEEK REMEDIES AT THE PROPER LEVELS, INCLUDING STATUTORY REDRESS AS APPROPRIATE. THIS REPORT IDENTIFIES SPECIFIC CONSTRAINTS REQUIRING CONCERTED AND IMMEDIATE ACTION. THE "PERSONNEL DEMONSTRATION PROJECT" NOW BEING CONDUCTED WITHIN THE NAVY IS A PRINCIPAL POSITIVE CONTRIBUTION.

RECOMMENDATION: REVIEW HIGH GRADE DISTRIBUTION

ACROSS DOD LABORATORIES, JUSTIFICATION FOR HIGH-GRADE RELIEF DOES NOT APPEAR CREDIBLE IN EVERY CASE. SERVICES SHOULD REVIEW HIGH-GRADE CEILING ALLOCATION TO THEIR LABORATORIES AND DISTRIBUTION AMONG LABORATORIES.

CONSIDERATION OF BROADER STUDY OF S&E IN DOD

- DOD HIGHLY DEPENDENT ON ITS S&E POPULATION
- THIS STUDY AND THE JLC STUDY TOGETHER COVER 60% OF TOTAL DOD CIVILIAN S&E WORK FORCE
- ALTHOUGH THESE STUDIES DO NOT SHOW DOD S&E MANNING IS AT CRISIS LEVELS, THEY DO IDENTIFY:
  - CURRENT MARGINAL SHORTAGES OF A BROAD RANGE OF S&E PERSONNEL IN DOD (PREDOMINANTLY ENGINEERING SPECIALTY SKILLS AND COMPUTER PROFESSIONALS)
  - SPECIFIC ACTIONS THAT OSD AND THE SERVICES SHOULD TAKE IN ORDER TO IMPROVE RECRUITMENT AND RETENTION OF CRITICAL S&E PERSONNEL
  - TRENDS AND FUTURE SKILL NEEDS THAT COULD DEVELOP INTO CRITICAL AREAS IN FUTURE YEARS

CONSIDERATION OF BROADER STUDY OF S&E IN DOD, Cont.

- SEVERAL UNRESOLVED ISSUES PROMPTING INITIATION OF A DOD S&E STUDY STILL REMAIN
  - HOW NATIONAL SHORTAGES WILL IMPACT ON ALL S&E ELEMENTS WITHIN DOD
  - NEED FOR A COMMON UNDERSTANDING OF THE DOD PROBLEM TO ALLOW
    - AN OVERALL DOD POLICY FOCUS ON THE S&E SHORTAGE ISSUE
    - A PROPOSED ROLE WHICH DOD SHOULD PLAY IN THE NATIONAL SECURITY TECHNICAL MANPOWER ARENA
    - A CONSENSUS ON APPROACHES TO TAKE WHICH WILL SOLVE DOD'S OWN INTERNAL TECHNICAL MANPOWER PROBLEMS
    - AN OVERALL DOD-LEVEL ACTION PLAN WHICH CAN UNIFY THESE AND OTHER EFFORTS INTO A COMMON DOD POSITION AND APPROACH

- RECOMMENDED OSD ACTIONS
  - DISTRIBUTE THE FINDINGS AND RECOMMENDATIONS OF THIS STUDY AND THE JLC STUDY TO OTHER SEGMENTS OF THE DOD HAVING SUBSTANTIAL S&E POPULATIONS NOT COVERED BY THESE STUDIES TO DETERMINE THE DEGREE OF COMMONALITY AND GENERAL APPLICABILITY
  - UNDERTAKE A DETAILED BROADER STUDY OF S&E ISSUES ACROSS THE DOD ONLY IF EXISTING STUDIES DO NOT PROPERLY ADDRESS THE NEEDS OF THE TOTAL DOD S&E POPULATION, OR IF NECESSARY TO DEVELOP ANSWERS TO UNRESOLVED ISSUES
  - BECAUSE OF THE IMPORTANCE OF COMPUTER-RELATED SPECIALTIES TO DOD, THE POTENTIAL SHORTFALLS OF VARIOUS COMPUTER SUBSPECIALTIES, AND THE EXPECTED SIGNIFICANT FUTURE GROWTH OF COMPUTER-RELATED INTERESTS, OSD SHOULD CONSIDER CONDUCTING AN IN-DEPTH STUDY OF THE STATUS OF COMPUTER PROFESSIONALS THROUGHOUT ALL OF THE DEPARTMENT OF DEFENSE WITH PARTICULAR EMPHASIS ON JOB SERIES DESIGNATIONS, SALARIES, AND CURRENT AND PROJECTED NEEDS.

POSTSCRIPT

IN A NUMBER OF INSTANCES, PERCEPTIONS CONCERNING THE LABORATORIES WERE NOT SUPPORTED BY NUMERICAL DATA. IT IS IN THE BEST INTEREST OF THE LABORATORIES THAT MANAGEMENT BE AWARE OF THESE INCONSISTENCIES AND UNDERSTAND THE UNDERLYING RATIONALE FOR THEM.

APPENDIX A
STUDY CHARTER

APPENDIX A

STUDY CHARTER

5 November 1981

MEMORANDUM FOR DR. HERBERT RABIN, CHAIRMAN, PERSONNEL AND MANPOWER WORKING GROUP, LABORATORY MANAGEMENT TASK FORCE

SUBJECT: Terms of Reference for the Study of the Status of Scientific and Engineering Personnel in the DoD Laboratories

Reference is made to my memorandum of 7 October 1981 asking you to undertake the above-cited study, as well as to my memorandum of 7 October to each of the Assistant Secretaries requesting their assistance in enabling us to begin this effort. This memo is in response to your request that we establish specific terms of reference to guide this study.

As I indicated in my memo to the Assistant Secretaries, "...a massive study of all areas would take considerable time which our current schedule and resources do not permit. Therefore, I intend to focus our initial efforts and recommendations on the laboratory community ... and secondarily, as time permits, broaden our research to include other areas of inquiry beneficial to the Services as a whole." In this regard, it is particularly vital that we have some initial data on the laboratories for our 15 December submission to the HASC, and a complete report on the status of personnel within the laboratories for the final March submission to the HASC.

Once this initial laboratory phase is completed, I would appreciate recommendations from your group with regard to a process and plan for completing the broader study which addresses the total issue DoD-wide. Such recommendations may include adding more members to your Study Panel, establishing a new Study Panel, exploring the potential for contracting out certain aspects of the work, establishing linkages with other organizations within the private and public sectors, and/or other such actions.

At the current time, I would like you and your group to focus your attention on the following issues and questions, with a progress report due in early December and a final report due in February, both of which will form in part the substance of our submissions to the HASC. This laboratory S&E study will focus on the problems of recruiting and retaining civilian scientists and engineers for the in-house laboratories. As tangential questions of military S&E personnel arise (for example in the Air Force where military personnel form a large fraction of S&E laboratory personnel), you may wish to include such data as are pertinent. Your efforts should address the following questions:

1. How many scientists and engineers by type are currently employed in the in-house laboratories? In what areas are they

employed? What vacancies currently exist in each functional job category? How long have they been vacant? Do these vacancies simply reflect current national trends relative to the supply of certain types of scientists and engineers, or are there other factors affecting laboratory recruitment and retention of S&E personnel that are unrelated to national supply/demand trends? What programs and missions are being affected by these vacancies?

2. Are all laboratories affected, or are there some laboratories which are not experiencing problems in recruitment and retention? If so, can we determine why?

3. What future needs for scientists and engineers are projected for the laboratories? Based on our current knowledge of existing supply/demand factors for scientists and engineers in the nation, what projected laboratory needs are expected to be difficult to fill in both the short and long-term?

4. What programs exist for ameliorating the problems of recruitment and retention of scientists and engineers? Are they short-term or long-range? What successes have they had to date? Are auditing procedures adequate to determine whether people who are benefited by these programs are retained within the system?

5. What recommendations do you have for conducting a broader study of this issue within Defense?

I have assigned Jeanne Carney of my staff to assist you in coordinating and managing the various aspects of the work to be done and to represent my office on the Personnel and Manpower Working Group.

As we have discussed, Bob Hermann's Task Force is also looking at the S&E manpower and personnel issues in the DoD laboratories, among other things. My understanding is, however, that this is a relatively small part of his study. My office will work out an arrangement with him to minimize any duplication or repetitive looking.

Thank you for agreeing to undertake this study and for your cooperation in assisting us further to look at other aspects of this task beyond the laboratory community.

George P. Millburn
Acting Deputy Under Secretary of Defense
for Research and Engineering

APPENDIX B

LABORATORY QUESTIONNAIRE

APPENDIX B

LABORATORY QUESTIONNAIRE

OFFICE OF THE UNDER SECRETARY OF DEFENSE

WASHINGTON DC 20301

RESEARCH AND ENGINEERING

7 JAN 1982

MEMORANDUM FOR Assistant Secretary of the Army (Research, Development and Acquisition)
Assistant Secretary of the Navy (Research, Engineering and Systems)
Assistant Secretary of the Air Force (Research, Development and Logistics)

SUBJECT: Questionnaire for the Study of the Status of Scientific and Engineering Personnel in the DoD Laboratories

Reference is made to my memorandum of 7 October 1981 describing our plans to conduct a study of the status of scientific and engineering personnel in DoD.

The first phase of this study will focus on the DoD in-house laboratories. While we will be accessing data from various sources in conducting the first phase of the study, we have determined that it is necessary for individual laboratory directors to provide us with certain types of data which we are unable to obtain elsewhere. The attached questionnaire has been designed to collect the essential data which we will need to arrive at a complete picture of the status of scientific and engineering personnel in the DoD laboratories.

Each laboratory is requested to complete the attached questionnaire and return two copies by COB 29 January 1982 through the respective Service representatives as indicated in the attached guidance.

Reports Control Symbol DD-DR&E(OT)8201 has been assigned to this reporting requirement.

Thank you for your cooperation. A complete report of this phase of the study will be available in April 1982.

George P. Millburn
Acting Deputy Under Secretary of Defense for Research and Engineering
(Research and Advanced Tehnology)

Attachment

QUESTIONNAIRE FOR THE STUDY OF THE STATUS OF SCIENTIFIC AND ENGINEERING PERSONNEL IN THE DOD LABORATORIES

Questionnaire Respondents: All DoD laboratories as cited in Attachment 1.

Background for Study: This study was directed by OUSDRE to be conducted under the aegis of the Laboratory Management Task Force (LMTF), Personnel and Manpower Working Group. The terms of reference are described in the attached memorandum dated 5 November 1981.

Membership of Study Panel:

Dr. Herbert Rabin, Chairman

Ms. Jeanne Carney - OSD(OUSDRE(R&AT))

Mr. Thomas Hatheway - OSD(MRA&L)

Mr. Robert Langworthy* Autovon 284-9561
Mr. Donald E. Cochran (Alternate)

Mr. Stuart Simon* Autovon 441-2751
Mr. Walter L. Clearwaters (Alternate)

COL David A. Smith - Air Force*
MAJ John Tucker (Alternate) Autovon 858-4162

*Point-of-Contact as pertains to questions on this questionnaire.

Procedures:

(a) All data will be collected by the DoD laboratories, with subsequent merging and analysis by the study group.

(b) Attachment 2 contains job series of civilian engineers, scientists and skilled technicians. Each Service should use its AFSC's, MOS's, NOBC/NEC's as appropriate.

(c) It is essential that the definitions, categories and breakouts requested be closely followed by all laboratory respondents in order to allow merging and analysis of the data. Although the emphasis of this study is on civilian S&E personnel needs, data for military S&E personnel should be included, in the same format to the degree possible. For laboratories where the level of military information is not applicable, a narrative response should be provided, indicating the role that the military plays and the need for military S&E qualifications.

(d) Questions requesting "perceptions, experience or, beliefs," should reflect the best objective judgement of the senior management officials of each laboratory. The senior military and civilian official of each laboratory are asked to forward the completed questionnaire under their joint signatures. It is intended that the completed questionnaire represent a consistent presentation of the S&E status and pertinent management perspectives of each laboratory. Therefore, it is suggested that the data base (charts) be reviewed by senior managers and/or the laboratory director as part of answering the questions. It is also suggested that the laboratory director complete his summary assessment, pages 37 to 39, based on the data base and answers to the other questions.

(e) The questionnaire is directed toward an understanding of the S&E status and needs across all DoD laboratories. As such this information is not to be used to evaluate individual laboratories.

(f) Answers to questions should be prepared accurately and with care, with responses to all of the questions. Some questions may not have exact answers, therefore, the "best" answer possible should be provided.

Completion Date: All questionnaires are to be completed and conveyed to the Study Panel by 29 January 1982 through the respective Service representatives (HQ DARCOM, Director of Navy Labs, Air Force Director of Labs).

TABLE OF CONTENTS

5 November 1981

MEMORANDUM FOR DR. HERBERT RABIN, CHAIRMAN, PERSONNEL AND MANPOWER WORKING GROUP, LABORATORY MANAGEMENT TASK FORCE

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5. What recommendations do you have for conducting a broader study of this issue within Defense?

I have assigned Jeanne Carney of my staff to assist you in coordinating and managing the various aspects of the work to be done and to represent my office on the Personnel and Manpower Working Group.

As we have discussed, Bob Hermann's Task Force is also looking at the S&E manpower and personnel issues in the DoD laboratories, among other things. My understanding is, however, that this is a relatively small part of his study. My office will work out an arrangement with him to minimize any duplication or repetitive looking.

Thank you for agreeing to undertake this study and for your cooperation in assisting us further to look at other aspects of this task beyond the laboratory community.

George P. Millburn
Acting Deputy Under Secretary of Defense
for Research and Engineering

Name of Laboratory Activity: ______________________________

Military Base/Location: ______________________________

Street Address: ______________________________

City: ______________________________

State: ______________________________

Zip Code: __________________

Parent Command: ______________________________

Point of Contact (Last name, first name, middle initial):
(for this questionnaire) ______________________________

Phone Number: Commercial (area code) ______________________________

Autovon ______________________________

INVENTORY DATA

1. How many part-time or temporary S&E workers were on board as of 30 September 1981?

End of FY 1981 Inventory (numbers)

	Co-op*	Aides*	Other* Temps	Part-time* Permanent
Civilians				
Scientists	____	____	____	____
Engineers	____	____	____	____
All Others	____	____	____	____
Total	____	____	____	____

2. How many of the above temporary S&E employees are rehired annuitants?

Scientists ______ Engineers ______

3. Based on your experience, please estimate the percentage of S&E part-time, co-op, aide and other workers who become full-time permanent employees and the percentage of these who remain with your activity 3 years or longer.

	% Of Those Who Become Full time permanent Employees	% Of Those Who Become Full-Time permanent Employees Who Remain 3 Or More Years
Part-time permament*	____	____
Co-op*	____	____
Aide*	____	____
Other Temporary*	____	____

* As defined in Federal Personnel Manual, Chapter 30, "Employment Programs".

4. What percentage of your allocated S&E manpower works on and what percentage of your laboratory budget is spent on the following types of work?

	% S&E Manpower	% Total Funds
Tech Base (6.1, 6.2, 6.3a)*	______	______
Systems Development (6.3b, 6.4)*	______	______
Test and Evaluation	______	______
Product Support	______	______
Other (specify)______	______	______
______________	______	______
______________	______	______
Total	100%	100%

5. What percentage, on a dollar basis, of your technical work is contracted out? _____%

6. What percentage of S&E manpower at your activity spends time accomplishing the following kinds of jobs?

	% S&E Manpower
In-house technical (Bench or "hands-on") work	________
Line management	________
Contract monitoring	________
Staff administration	________
Planning	________
Director/Advisory	________
Other (specify) ________	________
______________	________
Total	100%

* See R&D funding categories in DOD Budget Guidance Manual, DOD7110-1-M, p.516-1.

HOW MANY FULL-TIME PERMANENT S&E PERSONNEL WERE ON BOARD AS OF 30 SEPTEMBER, 1981 (END FY 1981)? ALSO PLEASE INDICATE THE HIGHEST DEGREE ATTAINED BY ALL THESE PERSONS BY JOB SERIES. (Actual numbers should be provided in chart cells)

END OF FY 81 INVENTORY (numbers)

Engineers	CIVILIAN												MILITARY							HIGHEST DEGREE		
	GS5	GS6	GS7	GS8	GS9	GS10	GS11	GS12	GS13	GS14	GS15	PL/SES GS16-18	01	02	03	04	05	06	07	B.S.	M.S.	Ph.D.
801 General Engineering																						
803 Safety Engineering																						
804 Fire Prevention Engineering																						
806 Materials Engineering																						
807 Landscape Architecture																						
808 Architecture																						
810 Civil Engineering																						
819 Environmental Engineering																						
830 Mechanical Engineering																						
840 Nuclear Engineering																						
850 Electrical Engineering																						
855 Electronics Engineering																						
858 Biomedical Engineering																						
861 Aeronautics Engineering																						
871 Naval Architecture																						
880 Mining Engineering																						
881 Petroleum Production and Natural Gas Engineering																						
890 Agriculture Engineering																						
892 Ceramic Engineering																						
893 Chemical Engineering																						

On Board - Personnel actually employed on as-of-date in a full-time permanent or equivalent status.

HOW MANY FULL-TIME PERMANENT S&E PERSONNEL WERE ON BOARD AS OF 30 SEPTEMBER, 1981 (END FY 1981)? ALSO PLEASE INDICATE THE HIGHEST DEGREE ATTAINED BY ALL THESE PERSONS BY JOB SERIES. (Actual numbers should be provided in chart cells)

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894 Welding Engineering																						
896 Industrial Engineering																						
Other (Specify Job Series & Position Title)																						
Scientists																						
101 Social Science																						
150 Geography																						
180 Psychology																						
190 General Anthropology																						
193 Archeology																						
401 General Biology																						
403 Microbiology																						
405 Pharmacology																						
408 Ecology																						
410 Zoology																						
413 Physiology																						
414 Entomology																						
430 Botany																						
434 Plant Pathology																						
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	CIVILIAN												MILITARY							HIGHEST DEGREE		
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436 Plant Protection and Quarantine																						
437 Horticulture																						
440 Genetics																						
454 Range Conservation																						
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460 Forestry																						
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660 Pharmacist																						
662 Optometrist																						

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[illegible]35 Speech Pathology & Audiology																						
668 Podiatrist																						
680 Dental Officer																						
690 Industrial Hygine																						
696 Consumer Safety																						
701 Veterinary Medical Science																						
1221 Patent Adviser																						
1223 Patent Classifying																						
1225 Patent Interference Examining																						
1226 Design Patent Examining																						
1301 Physical Science																						
1306 Health Physics																						
1310 Physics																						
1313 Geophysics																						
1315 Hydrology																						
1320 Chemistry																						
1321 Metallurgy																						
1330 Astronomy & Space Science																						
1340 Meteorology																						
1350 Geology																						

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1360 Oceanography																						
1370 Cartography																						
1372 Geodesy																						
1380 Forest Production Technology																						
1382 Food Technology																						
1384 Textile Technology																						
1386 Photographic Technology																						
1510 Actuary																						
1515 Operations Research																						
1520 Mathematics																						
1529 Mathematical Statistician																						
1530 Statistician																						
1540 Cryptography																						
1550 Computer Science																						
Other (specify Job Series & Position Title)																						

UTILIZATION

7. During the past year, how many of your employees have you had to assign to tasks where their experience might be much less than or greater than normally required? This experience could be either in a specific discipline (e.g., use of physicist to do a task you would have preferred an electrical engineer to do), or experience (e.g., use of an individual with fewer years experience than you would have preferred for a task or project.)

8. What percentage of the above management actions were caused by:

Total ceiling limitations	________%
High grade (GS13 and above) limitations	________%
Inability to locate and hire personnel with specific skills	________%
Management styles and/or organizational structure	________%

9. Please explain your answers to question #8.

10. What S&E pertise lost to retirement and other causes has not been replaced?

Job Series	Position Title	Grade Level	Number Needed

11. What percentage of your laboratory's S&E professionals are categorized as supervisory? ______________%

12. How many non-supervisory S&E personnel hold grades GS13 or above? ________

13. Describe your policies for promoting S&E professionals to high grades (GS/GM13 through PL/SES) without supervisory responsibilities.

14. How many non-S&E civilian employees (including co-ops) are participating in programs leading toward S&E qualifications? How many are being supported by federal funds?

Name of Program (Be specific)	# Non-S&E employees in programs leading to S&E qualifications	What jobs did these employees hold when entering program	Supported by federal funds YES	NO

VACANCIES AND DEPARTURES

Reflect the number of vacant positions by length of time since S&E incumbent left your activity. Use following definition of vacancies.

VACANCIES - Unfilled S&E billets/slots/positions previously filled by an S&E individual. When an activity is "manned" to its ceiling on 30 Sept with other than S&E individuals because sufficient S&E personnel cannot be recruited/hired, those S&E billets/slots/positions should still be considered vacant (unfilled) for the purpose of this questionnaire.

	CALENDAR DAYS VACANT				
	0 - 59	60 - 179	180 - 269	270 - 365	Over 365
Civilian					
Scientists					
Engineers					
Totals					
Military					
Scientists					
Engineers					
Totals					

VACANCIES AND DEPARTURES

REFLECT S&E POSITIONS UNFILLED BY S&E'S AS OF 30 SEPTEMBER, 1981 (END FY 1981). IDENTIFY BY JOB SERIES OR SPECIALTY CODE AND GRADE (ACTUAL NUMBERS). PLEASE USE FOLLOWING DEFINITION OF VACANCIES.

VACANCIES - Unfilled S&E billets/slots/positions previously filled by an S&E individual. When an activity is "manned" to its ceiling on 30 Sept with other than S&E individuals because sufficient S&E personnel cannot be recruited/hired, those S&E billets/slots/positions should still be considered vacant (unfilled) for the purpose of this questionnaire.

END FY 1981

UNFILLED POSITIONS (NUMBERS)

Engineers	CIVILIAN												MILITARY							Retired	Deceased	Transferred	Industry	School	Other
	GS5	GS6	GS7	GS8	GS9	GS10	GS11	GS12	GS13	GS14	GS15	PL/SES GS16-18	01	02	03	04	05	06	07						
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871 Naval Architecture																									
880 Mining Engineering																									

VACANCIES AND DEPARTURES

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END FY 1981

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Engineers (Cont'd)	CIVILIAN												MILITARY												
	GS5	GS6	GS7	GS8	GS9	GS10	GS11	GS12	GS13	GS14	GS15	PL/SES GS16-18	01	02	03	04	05	06	07	Retired	Deceased	Transferred	Industry	School	Other
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END FY 1981

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1221 Patent Adviser																									
1223 Patent Classifying																									
1225 Patent Interference Examining																									
1226 Design Patent Examining																									
1301 General Physical Science																									
1306 Health Physics																									
1310 Physics																									
1313 Geophysics																									
1315 Hydrology																									
1320 Chemistry																									
1321 Metallurgy																									

VACANCIES AND DEPARTURES

REFLECT S&E POSITIONS UNFILLED BY S&E'S AS OF 30 SEPTEMBER 1981 (END FY 1981). IDENTIFY BY JOB SERIES OR SPECIALTY CODE AND GRADE (ACTUAL NUMBERS). PLEASE USE FOLLOWING DEFINITION OF VACANCIES.

END FY 1981

UNFILLED POSITIONS (NUMBERS)

Scientists (Cont'd)	CIVILIAN												MILITARY												
	GS5	GS6	GS7	GS8	GS9	GS10	GS11	GS12	GS13	GS14	GS15	PL/SES GS16-18	01	02	03	04	05	06	07	Retired	Deceased	Xferred	Industry	School	Other
1330 Astronomy & Space Science																									
1340 Meteorology																									
1350 Geology																									
1360 Oceanography																									
1370 Cartography																									
1372 Geodesy																									
1380 Forest Production Technolgy																									
1382 Food Technology																									
1384 Textile Technology																									
1386 Photographic Technology																									
1510 Actuary																									
1515 Operations Research																									
1520 Mathematics																									
1529 Mathematical Statistician																									
1530 Statistician																									
1540 Cryptography																									
1550 Computer Science																									
Other (specify Job Series & Position Title)																									

15. Using a scale from 0 to 9, please rate how influential you believe that each of the following reasons was in your S&E personnel's decision to accept jobs (e.g, transfer, industry, school) outside your laboratory during the FY 1981 (0 stands for not influential, 9 stands for very influential).

Not Influential				Moderately Influential				Very Influential	
0	1	2	3	4	5	6	7	8	9

FY 1981 Departures

	Civilian			Military
	Under GS12	GS12	Over GS12	
Type of work	___	___	___	___
Opportunity for advancement elsewhere	___	___	___	___
Lack of opportunity for advancement in lab	___	___	___	___
Location of employment	___	___	___	___
Salary	___	___	___	___
Perceived reduction in federal benefits	___	___	___	___
Opportunity for continued education	___	___	___	___
Job Security	___	___	___	___
Use of skills	___	___	___	___
Lack of opportunity for advancement for promotable S&E personnel	___	___	___	___
Time spent in non-engineering/ non-scientific duties	___	___	___	___
Other (specify) ___________	___	___	___	___
______________________	___	___	___	___

CEILING AND IMPACT

16. What is the authorization/ceiling for your laboratory as of the end of FY 1981? Total _______ High Grades (GS13 and up) _______

17. Describe the mission impact, if any, of authorization/ceiling limitations? (including high grades) (Be as specific as possible).

18. Describe the management and organizational actions that have been required to live within these authorization/ceiling levels. (Be as specific as possible)

19. How do these impacts and actions affect the productivity of the S&E personnel? (Be as specific as possible)

20. What additional S&E personnel would you prefer to have within ceiling to perform your existing workload? (Job series are in Attachment 2)

Job Series	Position Title	Grade Level	Number Needed

21. What S&E personnel above ceiling would help you perform your existing workload more effectively? (Job series in Attachment 2)

Job Series	Position Title	Grade Level	Number Needed

PLEASE LIST BY JOB SERIES AND GRADE THE LABORATORIES AUTHORIZATION FOR S&E PERSONNEL (ESTABLISHED POSITIONS WITHIN PERSONNEL CEILINGS) AND VALIDATED REQUIREMENTS AS OF 30 SEPTEMBER 1981 (END FY 1981) AND REQUIREMENTS FOR 30 SEPTEMBER 1982 (FY 1982).

	TOTAL END FY 1981		TOTAL END FY 1982		AUTHORIZATION END OF FY 1981 CIVILIAN GRADES												AUTHORIZATION END OF FY 1981 MILITARY GRADES						
Engineers	AUTH.	REQ.	AUTH.	REQ.	GS5	GS6	GS7	GS8	GS9	GS10	GS11	GS12	GS13	GS14	GS15	PL/SES GS16-18	01	02	03	04	05	06	07
801 General Engineering																							
803 Safety Engineering																							
804 Fire Prevention Engineering																							
806 Materials Engineering																							
807 Landscape Architecture																							
808 Architecture																							
810 Civil Engineering																							
819 Environmental Engineering																							
830 Mechanical Engineering																							
840 Nuclear Engineering																							
850 Electrical Engineering																							
855 Electronics Engineering																							
858 Biomedical Engineering																							
861 Aeronautics Engineering																							
871 Naval Architecture																							
880 Mining Engineering																							
881 Petroleum Production & Natural Gas Engineering																							

Authorizations - Established positions to be hired or assigned against. Results from allocation of ceilings and end strengths authorized by Congress.

Requirements - Validated requirements for personnel above the allocated authorization. Should not be "blue sky" wish list. Should be recognized by Service Headquarters as valid request to man if authorized ceiling were raised.

PLEASE LIST BY JOB SERIES AND GRADE THE LABORATORIES AUTHORIZATION FOR S&E PERSONNEL (ESTABLISHED POSITIONS WITHIN PERSONNEL CEILINGS) AND VALIDATED REQUIREMENTS AS OF 30 SEPTEMBER 1981 (END FY 1981) AND REQUIREMENTS FOR 30 SEPTEMBER 1982 (FY 1982)

	TOTAL END FY 1981		TOTAL END FY 1982		AUTHORIZATION END OF FY 1981 CIVILIAN GRADES												AUTHORIZATION END OF FY 1981 MILITARY GRADES						
Engineers (Cont'd)	AUTH.	REQ.	AUTH.	REQ.	GS5	GS6	GS7	GS8	GS9	GS10	GS11	GS12	GS13	GS14	GS15	PL/SES GS16-16	01	02	03	04	05	06	07
890 Agriculture Engineering																							
892 Ceramic Engineering																							
893 Chemical Engineering																							
894 Welding Engineering																							
896 Industrial Engineering																							
Other (Specify Job Series & Position Title)																							
Engineer Subtotals																							
Scientists																							
101 Social Science																							
150 Geography																							
180 Psychology																							
190 General Anthropology																							
193 Archeology																							
401 General Biology																							
403 Microbiology																							

PLEASE LIST BY JOB SERIES AND GRADE THE LABORATORIES AUTHORIZATION FOR S&E PERSONNEL (ESTABLISHED POSITIONS WITHIN PERSONNEL CEILINGS) AND VALIDATED REQUIREMENTS AS OF 30 SEPTEMBER 1981 (END FY 1981) AND REQUIREMENTS FOR 30 SEPTEMBER 1982 (FY 1982).

	TOTAL END FY 1981		TOTAL END FY 1982		AUTHORIZATION END OF FY 1981 CIVILIAN GRADES												AUTHORIZATION END OF FY 1981 MILITARY GRADES						
Scientists (Cont'd)	AUTH.	REQ.	AUTH.	REQ.	GS5	GS6	GS7	GS8	GS9	GS10	GS11	GS12	GS13	GS14	GS15	PL/SES GS16-18	01	02	03	04	05	06	07
405 Pharmacology																							
408 Ecology																							
410 Zoology																							
413 Physiology																							
414 Entomology																							
430 Botany																							
434 Plant Pathology																							
435 Plant Physiology																							
436 Plant Protection and Quarantine																							
437 Horticulture																							
440 Genetics																							
454 Range Conservation																							
457 Soil Conservation																							
460 Forestry																							
470 Soil Science																							
471 Agronomy																							
480 General Fish & Wildlife																							

PLEASE LIST BY JOB SERIES AND GRADE THE LABORATORIES AUTHORIZATION FOR S&E PERSONNEL (ESTABLISHED POSITIONS WITHIN PERSONNEL CEILINGS) AND VALIDATED REQUIREMENTS AS OF 30 SEPTEMBER 1981 (END FY 1981) AND REQUIREMENTS FOR 30 SEPTEMBER 1982 (FY 1982)

	TOTAL END FY 1981		TOTAL END FY 1982		AUTHORIZATION END OF FY 1981 CIVILIAN GRADES												AUTHORIZATION END OF FY 1981 MILITARY GRADES						
Scientists (Cont'd)	AUTH.	REQ.	AUTH.	REQ.	GS5	GS6	GS7	GS8	GS9	GS10	GS11	GS12	GS13	GS14	GS15	PL/SES GS16-18	01	02	03	04	05	06	07
482 Fishery Biology																							
486 Wildlife Biology																							
487 Husbandry																							
498 Home Economics																							
601 General Health																							
602 Medical Officer																							
660 Pharmacist																							
662 Optometrist																							
665 Speech Pathology & Audiology																							
668 Podiatrist																							
680 Dental Officer																							
690 Industrial Hygiene																							
696 Consumer Safety																							
701 Veterinary Medical Science																							
1221 Patent Adviser																							
1223 Patent Classifying																							
1225 Patent Interference Examining																							

PLEASE LIST BY JOB SERIES AND GRADE THE LABORATORIES AUTHORIZATION FOR S&E PERSONNEL (ESTABLISHED POSITIONS WITHIN PERSONNEL CEILINGS) AND VALIDATED REQUIREMENTS AS OF 30 SEPTEMBER 1981 (END FY 1981) AND REQUIREMENTS FOR 30 SEPTEMBER 1982 (FY 1982)

Scientists (Cont'd)	TOTAL E.D FY 1981		TOTAL END FY 1982		AUTHORIZATION END OF FY 1981 CIVILIAN GRADES												AUTHORIZATION END OR FY 1981 MILITARY GRADES						
	AUTH.	REQ.	AUTH.	REQ.	GS5	GS6	GS7	GS8	GS9	GS10	GS11	GS12	GS13	GS14	GS15	PL/SES GS16-18	01	02	03	04	05	06	07
1226 Design Patent Examining																							
1301 General Physical Science																							
1306 Health Physics																							
1310 Physics																							
1313 Geophysics																							
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1320 Chemistry																							
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1380 Forest Production Technolgy																							
1382 Food Technology																							
1384 Textile Technology																							
1386 Photographic Technology																							

PLEASE LIST BY JOB SERIES AND GRADE THE LABORATORIES AUTHORIZATION FOR S&E PERSONNEL (ESTABLISHED POSITIONS WITHIN PERSONNEL CEILINGS) AND VALIDATED REQUIREMENTS AS OF 30 SEPTEMBER 1981 (END FY 1981) AND REQUIREMENTS FOR 30 SEPTEMBER 1982 (FY 1982)

	TOTAL END FY 1981		TOTAL END FY 1982		AUTHORIZATION END OR FY 1981 CIVILIAN GRADES												AUTHORIZATION END OF FY 1981 MILITARY GRADES						
Scientists (Cont'd)	AUTH.	REQ.	AUTH.	AUTH.	GS5	GS6	GS7	GS8	GS9	GS10	GS11	GS12	GS13	GS14	GS15	PL/SES GS16-18	01	02	03	04	05	06	07
1510 Actuary																							
1515 Operations Research																							
1520 Mathematics																							
1529 Mathematical Statistician																							
1530 Statistician																							
1540 Cryptography																							
1550 Computer Science																							
Other (Specify Job Series & Position Title)																							
Scientist Subtotals																							

22. What are your estimated future needs for S&E personnel based on guidance of the current (FY 83-87) five year Defense program? (What authorization/ceiling would be required?)

End FY 1987 S&E Total Future Requirements

Civilians

Number of Scientists	________
Number of Engineers	________
Total	________

Military

Number of Scientists	________
Number of Engineers	________
Total	________

23. Will there be any significant increases or decreases in specific job series or title of subdiscipline within your requirements?

No ________

Yes, significant increase ________ Yes, significant decrease ________

Job Series or subdisciplines ________________________________

Why has this occurred? ________________________________

____

____

____

24. The above data may not fully illuminate shortages in multi-disciplinary areas (e.g., S&E skills in artificial intelligence) Please provide comments and specify which multi-disciplinary areas you see as problematic

RECRUITMENT AND RETENTION

25. How long has it generally been taking for your laboratory to accomplish the following personnel actions?

Average Days to Accomplish Actions by Category

	LEVEL			
	GS5-7	GS9-12	GS13-15	PL/SES/GS16-18
Category				
Internal Processing Prior to Advertising	____	____	____	____
From Advertisement to Beginning of Review Process	____	____	____	____
Review and Selection Process	____	____	____	____
Approval Above Laboratory Level	____	____	____	____
From Final Approval to Employee Reports to Work	____	____	____	____

26. Please indicate the effectiveness of the following methods of recruiting civilian S&E's.

Not Effective	1	Effective	3
Somewhat Effective	2	Very Effective	4

	Entry Level	Journeyman
Newspaper/Technical Journal Ads	____	____
Co-op Programs	____	____
Visits to Schools/Industry	____	____
Visits to Minority Schools	____	____
Follow-up Interviews/Tours at Lab	____	____
Other (specify) ____________	____	____
______________________________	____	____

27. Who recruits new civilian S&E employees at schools/industry for your laboratory? Please indicate the percentage of recruitment that is done by the following types of personnel.

	Entry Level	Journeyman
Senior Management	____%	____%
Civilian Personnel	____%	____%
Technical Management	____%	____%
Journeyman S&E's	____%	____%
Other (specify) ________________	____%	____%
TOTAL	100 %	100 %

28. What percentage of new S&E civilian hires come from the following sources?

	Entry Level	Journeyman
Transfers/reassignments from other Federal activities	____%	____%
Industry	____%	____%
Universities (non-co-op)	____%	____%
Other government (non-Federal)	____%	____%
Co-op conversions	____%	____%
Other (specify)	____%	____%
TOTAL		100%

29. What is the rejection rate of offers (formal and informal) made to S&E selectees during FY 1981 by the following grade categories?

GS5-7	____%	GS12-15	____%
GS9-11	____%	PL/SES	____%

30. Using a scale from 0 to 9, please rate how important the reasons that are given for taking a job in the laboratory; as well as the reasons that are given for not taking a job (0 stands for no importance, 9 stands for very important.

No Importance				Moderately Important					Very Important
0	1	2	3	4	5	6	7	8	9

	Entry Level		Journeyman	
	Taking	Not Taking	Taking	Not Taking
Type of work	___	___	___	___
Opportunity for advancement	___	___	___	___
Location of employment	___	___	___	___
Salary	___	___	___	___
Opportunity for continued education	___	___	___	___
Job security	___	___	___	___
Use of skills	___	___	___	___
Lack of other offers	___	___	___	___
Other (specify) ________	___	___	___	___
________________	___	___	___	___

31. What is the grade distribution of new civilian S&E personnel acquired during FY 1981?

Grade	Number
GS5-7	___
GS9-11	___
GS-12	___
GS-13	___
GS-14	___
GS-15	___
PL/SES	___

32. What percentage of civilian vacancies are filled by?

	Non-Federal New Hire	Federal Reassignment or Transfers	Merit Promotion Within Labortory	Totals
GS5-7	____%	____%	____%	100%
GS7-9	____%	____%	____%	100%
GS9-11	____%	____%	____%	100%
GS-12	____%	____%	____%	100%
GS13-15	____%	____%	____%	100%
SES/PL	____%	____%	____%	100%

33. What programs or efforts exist in your laboratory for ameliorating the problems of recruitment and retention of S&E personnel?

State nature of program and date of initiation of program.

Name of Program	Describe Program	(YYMMDD) Date Program Initiated	% Recruited Because of Program	% Retained Because of Program

34. Are internal auditing or monitoring procedures adequate to determine retention of people who are benefited by these programs?

yes _____ no _____

If no, explain

35. Are there particular circumstances at your laboratory which make recruitment and retention easier (or harder)? (For example, housing problems, geographical location, etc.)

	Circumstances Which Make Easier	Circumstances Which Make Harder	Explain
Recruitment			
Retention			

36. Provide a statement about the quality of personnel recruited recently as compared to five or ten years ago. Have you maintained your S&E needs by recruiting at an education/experience level lower than you desire?

37. Please give the percentage of S&E civilian hires (FY 1981) with newly acquired baccalaureate degrees who graduated in the top, second, third and bottom quarters of their college class.

	Top Quarter	Second Quarter	Third Quarter	Bottom Quarter
Scientists	____%	____%	____%	____%
Engineers	____%	____%	____%	____%

38. List the names of the colleges/universities from which the all new civilian S&E hires graduated, along with their degrees and majors.

College/University	Degree	Major	Number

39. What percentage of your scientists and engineers take advantage of government-sponsored training programs?

____%

40. What types of programs are offered to your S&E personnel to assure that they keep their skills up-to-date and what percentage participate in such programs?

Type of Program	Length in Days	Where Offered	Government Sponsored Yes	Government Sponsored No	% S&E Who Participate in Program

41. What are the five S&E technical skills (e.g., stress analysis, microelectronics) most critical to your mission and how does your current work force measure up to these skills? (Job series in Attachment 2)

	Skills	Most Applicable Job Series#	% S&E Work Force Shortage in These Skills	% S&E Work Force Current in These Skills	NOTES
1)					
2)					
3)					
4)					
5)					

42. How do you implement plans to upgrade your S&E personnel in required skills?

43. What are you doing to assure that your S&E work force has these critical skills?

44. How many civilian and military S&E personnel completed long term training (i.e., greater than 120 days) during the past 5 years?

civilian _____ military _____

45. What constraints, barriers, or limitations inhibit greater use of long term training? Rank the level of importance of each factor from 0 (no importance) to 9 (very important).

_____ Personnel Ceilings

_____ Cost

_____ Lack of Interested Individuals

_____ Lack of Qualified Individuals

_____ Other

SKILLED TECHNICIANS

WE WOULD LIKE INFORMATION ON THE SKILLED TECHNICIANS EMPLOYED BY YOUR LABORATORY. (See attachment 2).

Please identify five major categories of skilled technicians in your lab and place the name of each category in the five spaces at the top of the chart below. If you include more than one series or type, explain below. Thereafter, answer each of the questions as it relates to each category. Include military and civilian technicians in your answer.

FIVE MAJOR CATEGORIES OF SKILLED TECHNICIANS

	1	2	3	4	5
Name of skilled technician category					
Number currently employed					
Number currently authorized					
Estimated number needed in FY 1987					
Average age of current workers					
Average number of years working in lab					
Highest educational attainment: Less than high school graduate					
High school graduate					
Some college					
College graduate					
Annual turnover rate					
Rate difficulty in acquiring technicians from 1 (little difficulty) to 5 (very difficult).					
Rate difficulty in retaining technicians from 1 (little difficulty) to 5 (very difficult).					

SKILLED TECHNICIANS (Cont'd)

WE WOULD LIKE INFORMATION ON THE SKILLED TECHNICIANS EMPLOYED BY YOUR LABORATORY. (See attachment 2).

Please identify five major categories of skilled technicians in your lab and place the name of each category in the five spaces at the top of the chart below. If you include more than one series or type, explain below. Thereafter, answer each of the questions as it relates to each category. Include military and civilian technicians in your answer.

FIVE MAJOR CATEGORIES OF SKILLED TECHNICIANS

		1	2	3	4	5
Name of skilled technician category.						
Do you perceive a shortage in this category?	Yes					
	No					
If yes: Rate the impact on your mission from 1 (little impact) to 5 (strong impact)						
Rate the impact on support to professionals from 1 (little impact to 5 (strong impact)						
If no: Have you used skilled technicians to supplement your work force in areas where there is a shortage of S&E personnel?	Yes					
	No					
If yes:* How successful has this been?	Not successful					
	Moderately successful					
	Very successful					
*Explain						

What is the total number of skilled technicians employed in your laboratory? ____________

Comments (e.g. regarding shortages, impact, successful ideas used for hiring, retaining, promoting, etc.).

LABORATORY DIRECTOR SUMMARY QUESTIONNAIRE

46. Has an inability to fill vacancies adversely affected laboratory mission areas? If so, to what degree have programs and/or mission areas been affected and now?

YES ________ NO ________

If yes, please explain using the following table.

NEGATIVE IMPACT ON PROGRAM AND MISSION OF VACUUM

Program or Mission Area Title	Negative Impact			Explanation of Impact
	Minor	Moderate	Major	

47. Assess in narrative the current inventory of S&E personnel as to their (1) quality, (2) age, (3) currency, (4) tendacy to remain in the work force, (5) attitudes toward their work, (6) other notable qualities.

Quality:

Age:

Currency of Knowledge:

Retention:

Attitudes:

Other:

48. Identify any aspect of policy, procedures, management, or organization, that impact on your ability to resolve these S&E problems.

49. Provide a summary narrative assessing the S&E personnel status, concerns, or issues from the perspective of your activity (current and projected). Add any observations not identified elsewhere. Please provide your recommendations for the resolution of the concerns and issues you have expressed about the scientists, engineers, and skilled technicians.

List DoD Laboratories

Army Laboratory Activities

Armament R&D Command[1]
Atmospheric Sciences Lab
Avionic R&D Activity
Ballistic Research Lab
Chemical Systems Lab
Combat Surveillance & Target Acquisition Lab
Communications-Electronics R&D Center
Electronics Technology & Devices Lab
Electronics Warfare Lab
Harry Diamond Lab
Human Engineering Lab
Materials & Mechanics Research Center
Missile Command[2]
Mobility Equipment R&D Command
Natick R&D Labs
Night Vision & Electro-Optics Lab
Research & Technology Labs (AVRADCOM)[3]
Signals Warfare Lab
Tank-Automotive R&D Center[4]
Army Research Institute
Cold Regions R&E Lab
Construction Engineering Research Lab
Engineer Topographic Laboratories
Engineer Waterways Experiment Station
Aeromedical Research Lab
Institute of Dental Research
Institute of Surgical Research
Letterman Army Institute of Research
Medical Bioengineering R&D Lab
Medical R&D Command
Medical Research Institute of Chemical Defense
Medical Research Institute of Infectious Diseases
Research Institute of Environmental Medicine
Walter Reed Army Institute of Research
Overseas Operations Branch

NOTES:

[1] Includes the Benet Lab, Fire Control & Small Caliber Weapons Systems Lab and Large Caliber Weapons Systems Lab

[2] Includes the Missile Lab

[3] Includes the Aeromechanics Lab, Applied Technology Lab, Propulsion Lab and Structures Lab

[4] Includes the Tank-Automotive Concepts Lab and Tank-Automotive Systems Lab

Navy Laboratory Activities

Naval Research Laboratory, Washington, DC
Naval Biosciences Laboratory, Oakland, CA
Naval Ocean Research & Development Activity, Bay St. Louis, MS
Naval Arctic Research Laboratory, Point Barrow, AK
Naval Air Development Center, Warminster, PA
Naval Coastal Systems Center, Panama City, FL
Naval Ocean Systems Center, San Diego, CA
Navy Personnel Research & Development Center, San Diego, CA
David W. Taylor Naval Ship Research & Development Center, Bethesda, MD
Naval Surface Weapons Center, Dahlgren, VA
Naval Underwater Systems Center, Newport, RI
Naval Weapons Center, China Lake, CA
Naval Environmental Prediction Research Facility, Monterey, CA
Navy Clothing & Textile Research Facility, Natick, MA
Naval Civil Engineering Laboratory, Port Hueneme, CA
Naval Medical Research Institute, Bethesda, MD
Naval Health Research Center, San Diego, CA
Naval Aerospace Medical Research Laboratory, Pensacola, FL
Naval Submarine Medical Research Laboratory, New London, CT
Naval Dental Research Institute, Great Lakes, IL
Naval Medical Research Unit #2, Manilla, Philippines and Djakarta, Indonesia
Naval Medical Research Unit #3, Cairo, Egypt
Naval Biodynamics Laboratory, New Orleans, LA
Naval Medical Research Institute Toxicology Detachment, Dayton, Ohio
Naval Air Propulsion Center, Trenton, NJ

Air Force Laboratory Activities

Air Force Wright Aeronautical Laboratories
Air Force Aerospace Medical Research Laboratory
Air Force Armament Laboratory
Engineering Services Laboratory, HQ AFESC/RD
Frank J. Seiler Research Laboratory
Air Force Geophysics Laboratory
Air Force Human Resources Laboratory
Air Force Rocket Propulsion Laboratory
Rome Air Development Center
United States Air Force School of Aerospace Medicine
Air Force Weapons Laboratory

TOTAL - 71

OPM Civilian Job Series for S&E Personnel

101 Social Science
150 Geography
180 Psychology
184 Sociology
190 General Anthropology
193 Archeology
401 General Biology
403 Microbiology
405 Pharmacology
408 Ecology
410 Zoology
413 Physiology
414 Entomology
430 Botany
434 Plant Pathology
435 Plant Physiology
436 Plant Protection and Quarantine
437 Horticulture
440 Genetics
454 Range Conservation
457 Soil Conservation
460 Forestry
470 Soil Science
471 Agronomy
480 General Fish & Wildlife
482 Fishery Biology
486 Wildlife Biology
487 Husbandry
498 Home Economics
601 General Health
602 Medical Officer
660 Pharmacist
662 Optometrist
665 Speech Pathology & Audiology
668 Podiatrist
680 Dental Officer
690 Industrial Hygiene
696 Consumer Safety
701 Veterinary Medical Science
*801 General Engineering
803 Safety Engineering
804 Fire Prevention Engineering
806 Materials Engineering
807 Landscape Architecture
808 Architecture
810 Civil Engineering
819 Environmental Engineering
830 Mechanical Engineering
840 Nuclear Engineering
850 Electrical Engineering
855 Electronics Engineering
858 Biomedical Engineering
861 Aeronautics Engineering
871 Naval Architecture
880 Mining Engineering
890 Agriculture Engineering
892 Ceramic Engineering
893 Chemical Engineering
894 Welding Engineering
896 Industrial Engineering
1221 Patent Adviser
1223 Patent Classifying
1225 Patent Interference Examining
1226 Design Patent Examining
1301 Physical Science
1306 Health Physics
1310 Physics
1313 Geophysics
1315 Hydrology
1320 Chemistry
1321 Metallurgy
1330 Astronomy & Space Science
1340 Meteorology
1350 Geology
1360 Oceanography
1370 Cartography
1380 Forest Products Technology
1382 Food Technology Actuary
1384 Textile Technology
1386 Photographic Technology
1510 Actuary
1515 Operations Research
1520 Mathematics
1529 Mathematical Statistician
1530 Statistician
1540 Cryptography
1550 Computer Science

*These series 800 jobs are categorized as engineers for the purpose of the study.

(Cont'd)

SKILLED TECHNICIANS -- Generally non-professionals working on an RDTE project or program in support of a professional.

102	Social Science Technician	667	Orthopedist & Prosthetist
181	Psychological Technician	683	Dental Laboratory Technician
404	Biological Technician	698	Environmental Health Technician
421	Plant Protection Technician	699	Health Technician
455	Range Technician	704	Animal Health Technician
458	Soil Conservation Technician	802	Engineering Technician
462	Forestry Technician	817	Surveying Technician
642	Nuclear Medicine Technician	856	Electronics Technician
644	Medical Technologist	895	Industrial Engineering Technician
645	Medical Technician	1202	Patent Technician
646	Pathology Technician	1311	Physical Science Technician
647	Medical Radiology Technician	1316	Hydrologic Technician
648	Therapeutic Radiological Technologist	1341	Meteorological Technician
649	Medical Machine Technician	1371	Cartographic Technician
661	Pharmacy Technician	1374	Geodetic Technician
664	Restoration Technician	1521	Mathematics Technician

Definitions for Completing Questionnaire

Military Skill Codes[1]	Air Force Specialty Code	Army Primary MOS	NBOC/ NEC
Engineers	XXX	XXX	XXX
Scientist	XXX	XXX	XXX
Skilled Tech	XXX	XXX	XXX

[1] Each Service is requested to provide a list of the codes utilized to identify each category listed.

APPENDIX C
DMDC DATA REQUEST

APPENDIX C

DMDC DATA REQUEST

DMDC REQUEST

ALL COMPUTER RUNS BY EACH LAB SEPARATELY (UIC),[1] THEN AGGREGATE BY SERVICE, CONTROL FOR S&E AND TECHNICIANS

RUN CIVILIAN AND MILITARY PERSONNEL SEPARATELY.[2]

RUN S&E SEPARATELY FROM TECHNICIANS

I. DESCRIPTION OF LABORATORY VARIABLES - List by number, percent, and average (i.e., median and mean where appropriate)

Run for each year as of 30 September 1977, 1978, 1979, 1980, 1981.

Tape Position	Variable Name	Category
23 - 27	Occupational Series Military Specialty Code[3]	See Attachment 2
12	Work Schedule	1 = Full-time 2 = Part-time 3 = Intermittent
34	Special Program Identification	1 = Stay in School Campaign 2 = Summer Aid 3 = Federal Summer Intern 4 = Federal Junior Fellowship 5 = Work Release Program 6 = Cooperative Education 9 = Public Service Careers 10 = Trainee
	Number of special program participants who became full-time permanent employees	
44	Sex	
48	Grade[4]	
54	Education Level	1 - 3 = Less than high school 4 - 6 = High school graduate 7 - 11 = College, less than B.S. 12 - 14 = College graduate 15 - 16 = Professional degree 17 - 20 = Master's degree and post Master's 21 - 22 = Doctorate degree and post doctorate

55	Year Degree Obtained	To be worked out from frequency
56 - 57	Academic Discipline	Code to be obtained
58	Minority Group	
80	Years of Federal Service	1 = Under 5 years 2 = 5 - 9 years 3 = 10 - 14 years 4 = 15 - 19 years 5 = 20 - 24 years 6 = 25 - 30 years 7 = Over 30 years
81	Age	1 = Under 25 2 = 25 - 35 years 3 = 36 - 45 years 4 = 46 - 55 years 5 = Over 55 years
84 - 88	Yearly Compensation	1 = Under $7,500 2 = $ 7,500 - $15,000 3 = $15,001 - $25,000 4 = $25,001 - $30,000 5 = $30,001 - $35,000 6 = $35,001 - $40,000 7 = $40,001 - $45,000 8 = $45,001 - $50,000 9 = Over $50,000
94	Retirement Eligibility Code	
	Promotion History (8 year limit)	
	Time in Grade	
	Participant in Training Program	
	Name of Training Program	
	Length of Training	
	Source of Training Funds	
	Number of Departures	
	Reasons for Departure	

$$\text{Turnover Rate} = \frac{(\text{Gain} + \text{Loss}) - \text{Gain} - \text{Loss}}{2 \times \text{Population}}$$

OCCUPATIONAL GROUPINGS[3]

Engineers

9 WEAPONS

10 AERONAUTICS 861

11 BUILDING = 808 architecture

12 CHEMICAL 893

13 ELECTRICAL 850, ELECTRONICS 855

14 GENERAL = 801 general, 803 safety, 804 fire prevention, 896 industrial

15 MATERIALS = 806 materials, 892 ceramic, 894 welding

16 MECHANICAL = 830 mechanical

17 NATURAL RESOURCES = 880, mining, 881 petroleum and natural gas, 890 agricultural, 807 landscape architecture, 819 environmental

19 871 naval architecture

Scientists

20 BIOLOGY = 401 general biology, 403 microbiology, 440 genetics, 410 zoology, 413 physiology, 414 entomology, 487 husbandry, 701 veterinary medical science, 430 botany, 434 plant pathology, 435 plant physiology, 436 plant protection and quarantine, 437 horticulture

21 COMPUTER SCIENCE 1550

22 EARTH = 408 ecology, 454 range conservation, 457 soil conservation, 460 forestry, 470 soil science, 471 agronomy, 1350 geology, 1372 geodesy, 1370 cartography, 1380 forest production technology

23 GENERAL = 1221 patent adviser, 1223 patent classifying, 1225 patent interference, 1226 design patent, 1384 textile technology, 1386 photographic technology

24 HEALTH = 651 general health, 665 speech pathology and audiology, 690 industrial hygiene, 498 home economics, 1382 food technology, 696 consumer safety, 1306 health physics

25 MATHEMATICS = 1510 actuary, 1515 operations research, 1520 mathematics, 1529 mathematical statistician, 1530 statistician, 1549 cryptography

26 MEDICAL = 405 pharmacology, 660 pharmacist, 602 medical officer, 662 optometrist, 668 podiatrist, 680 dental officer

27 PHYSICAL SCIENCE = 1301 physical science, 1310 physics, 1313 geophysics, 1320 chemistry, 1321 metallurgy, 1330 astronomy and space science, 1340 metereology

28 SEA = 480 general fish and wildlife, 482 fishery biology, 486 wildlife biology, 1315 hydrology, 1360 oceanography

29 SOCIAL SCIENCES = 101 social sciences, 150 geography, 180 psychology, 190 general anthropology, 193 archeology

BIOLOGICAL = 404 biological, animal health tech

EARTH = 421 plant protection, 455 range tech, 458 soil conservation, forestry 462

ENGINEER = 802 engineering tech, 817 surveying tech, 856 electronics tech, 895 industrial engineering tech. patent tech

MEDICAL = 642 nuclear medicine, 644 medical technologist, 645 medical technical, 646 pathology tech, 647 medical radiology. 648 therapeutic radiological, 649 medical machine, 661 pharmacy, 664 retoration, 667 orthopedist and prosthetist, 683 dental laboratory, 698 environmental health, 699 health, tech

PHYSICAL SCIENCE = 1311 physical science tech, 1316 hydrologic tech, 1341 meteorological tech, 1371 cartographic tech, 1374 geodetic tech, 1521 mathematics tech

SOCIAL SCIENCES = 102 social science technical, 181 psychological tech

Age of S&E Work Force by Year

End of Fiscal Year

Age	1977		1978		1979		1980		1981
	#	%	#	%	#	%	#	%	#
Under 25 Years									
25-35 Years									
46-55 Years									
Over 55 Years									
TOTALS									
Mean									
Median									

II. TWO WAY TABLES[5]

The two way tables will present the personal characteristics and work related data of scientists, engineers, and skilled technicians. Wherever possible, variables will be categorized, so as to facilitate the analysis. Below is presented the job series categorizations[6] and sample tables. End of fiscal year 1981 figures will be reported.

Age by Occupational Grouping
(Percentages reported)

Occupational Groupings	Under 25	Years of Age 25-35	36-45	46-55	Over 55	N
Engineers						
Aeronautics						
Building						
Chemical						
Electrical/Electronics						
General						
Materials						
Mechanical						
Natural Resources						
Naval Architecture						
Subtotal Number						
Scientists						
Biology						
Computer Science						
Earth Science						
General Science						
Health						
Mathematics						
Medical						
Physical Science						
Sea Science						
Social Science						
Subtotal Number						
Skilled Technicians						
Biological						
Earth Science						
Engineer						
Medical						
Physical Science						
Social Science						
Subtotal Number						

Other Tables in this format with:
- Sex
- Work schedule
- Grade
- Years of federal service
- Yearly salary
- Minority group
- Retirement eligibility
- Turnover rate
- Number of departures
- Reasons for departures
- Training program participant
  - type of training
  - purpose of training
  - source of training
  - direct costs
  - indirect costs
  - on duty hours
  - off duty hours
- 10 year promotion history
- Time in grade
- Education

Job Series and Academic Discipline

Are people working in jobs related to their academic major?

<u>Job Series Uncategorized</u>	<u>Academic Major</u>

Grade by Tenure, Education, Sex, Minority Group
(Percentages reported)

	GRADE				
Years of Federal Service	GS 5-7	GS 9-12	GS 13-15	PLSES/GS16-18	N
Under 5					
5-9					
10-14					
15-19					
20-24					
25-30					
Over 30					
Educational Attainment					
Less than High School					
Less than B.S.					
Baccalaureate					
Professional Degree					
Master's and Post Master's					
Doctorate and Post Doctorate					
Sex					
Male					
Female					
Minority Group					
Negro					
Spanish					
Asian					
American Indian					

Also tables with:
- Yearly Salary
- Retirement Eligibility
- Training Program Data
- Promotion History
- Time in Grade

Turnover Rate by Tenure, Grade, Education, Age...

Years of Federal Service
- Under 5
- 5-9
- 10-14
- 15-19
- 20-24
- 25-30
- Over 30

Grade
- GS 5-7
- GS 9-12
- GS 13-15
- PL/SES/GS 16-18

Educational Attainment
- Less than B.S.
- Baccalaureate Degree
- Professional Degree
- Master's Degree and Post Master's
- Doctorate and Post Doctorate

Age
- Under 25
- 25-35
- 36-45
- 46-55
- Over 55

Also tables with:
- Training Program Data
- Promotion History

III. Controlled two-way tables.

This analysis looks at two-way relationships at the end of fiscal years 1977-1981. (see sample table)

Analysis of variance routines will be undertaken to ascertain whether or not there are statistically significant differences between years.

Average Salaries by Occupational Grouping at End
of Fiscal Years 1977-1981
(mean salaries reported)

Occupational Groupings	1977	1978	1979	1980	1981
		End of Fiscal Years			
Engineers					
Aeronautics					
Building					
Chemical					
Electrical/Electronics					
General					
Materials					
Mechanical					
Natural Resources					
Naval Architecture					
Subtotal Number					
Scientists					
Biology					
Computer science					
Earth science					
General science					
Health					
Mathematics					
Medical					
Physical science					
Sea science					
Social science					
Subtotal Number					
Skilled Technicians					
Biological					
Earth Science					
Engineer					
Medical					
Physical Science					
Social Science					
Subtotal Numbers					

Tables also with:
- Average grade
- Average age
- Turnover rates

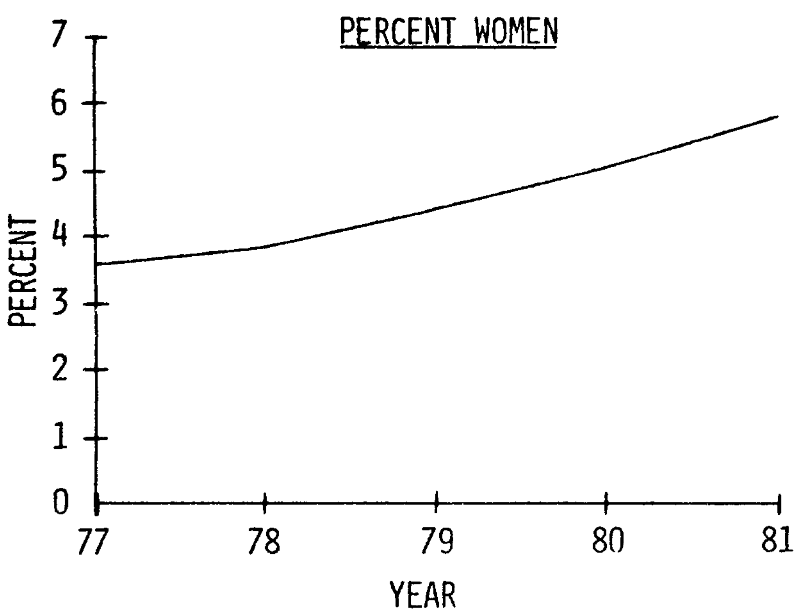
APPENDIX D
BACKUP DATA IN SUMMARY FORM

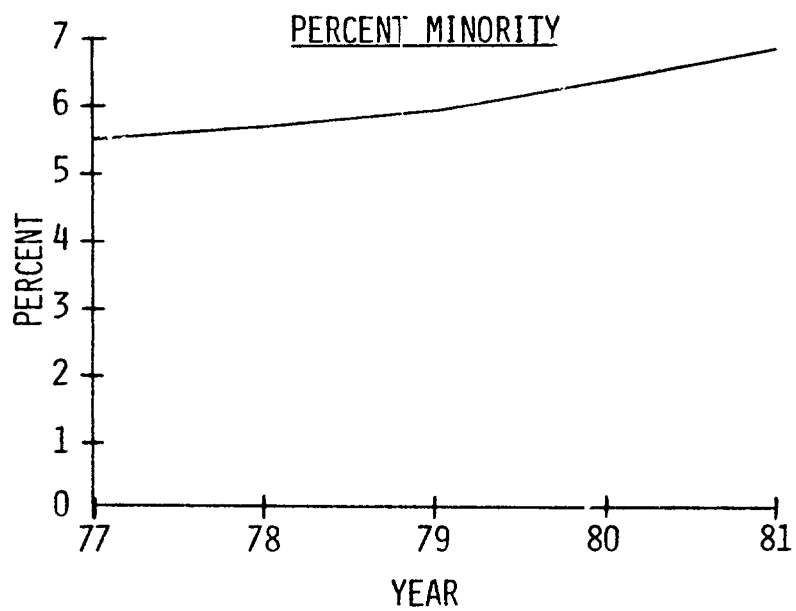
APPENDIX D

BACKUP DATA IN SUMMARY FORM

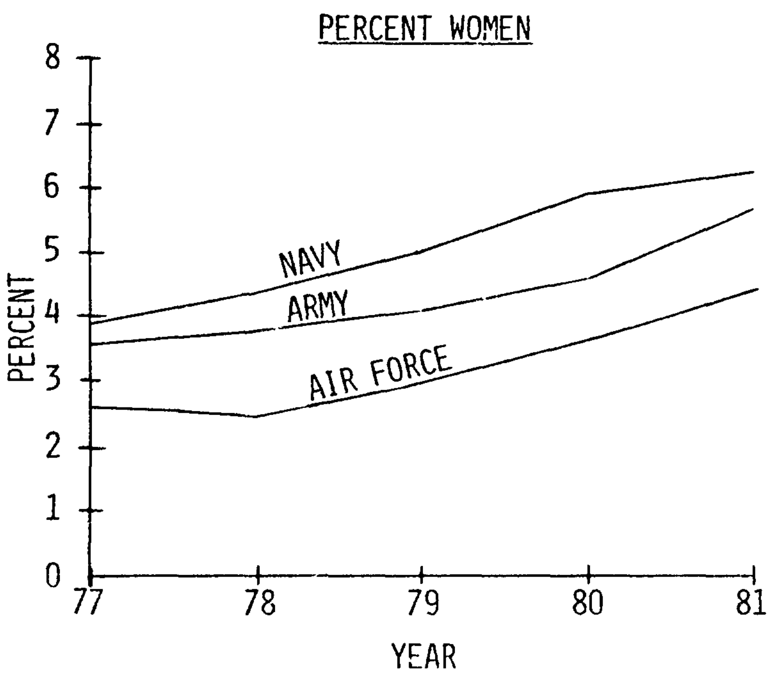
TABLE OF CONTENTS

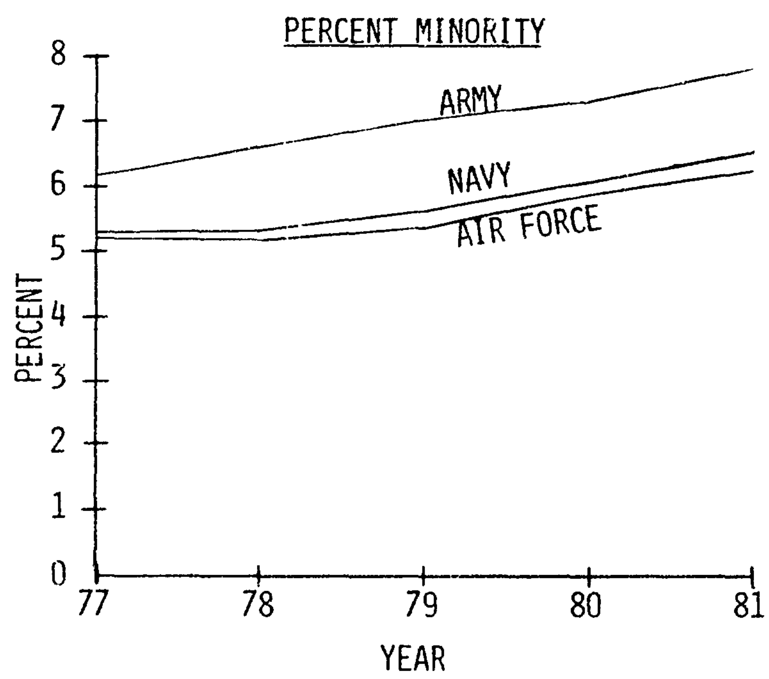
CIVILIAN S&E WOMEN AND MINORITY EMPLOYMENT



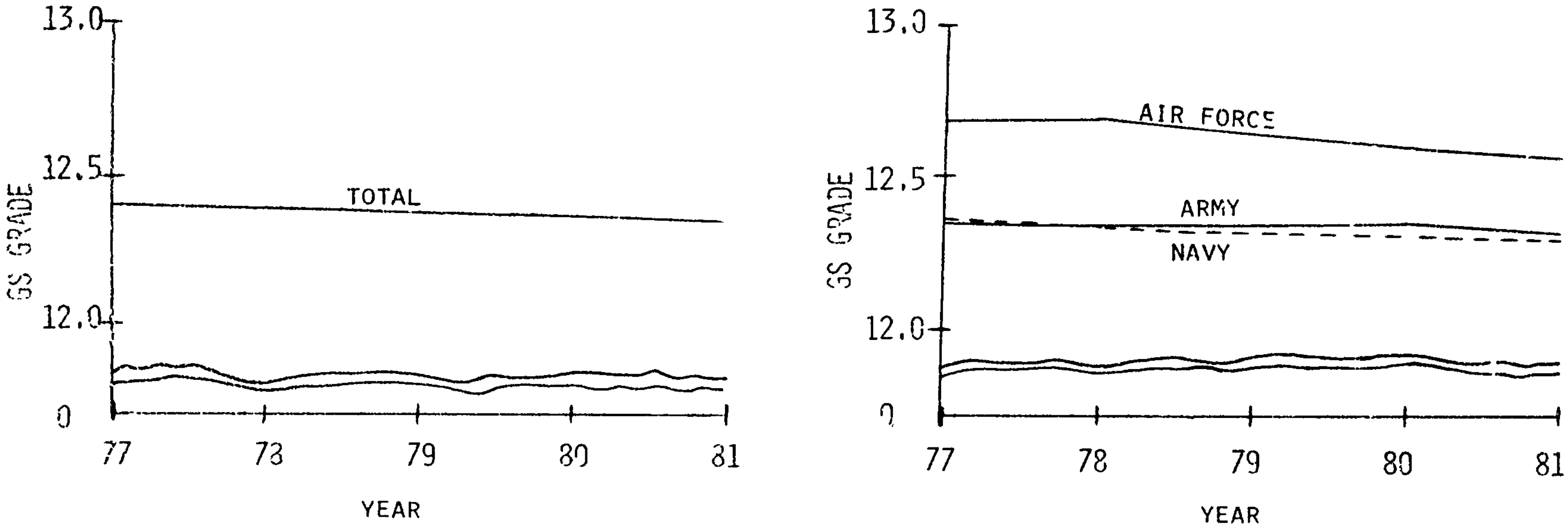


CIVILIAN S&E WOMEN AND MINORITY EMPLOYMENT, BY SERVICE

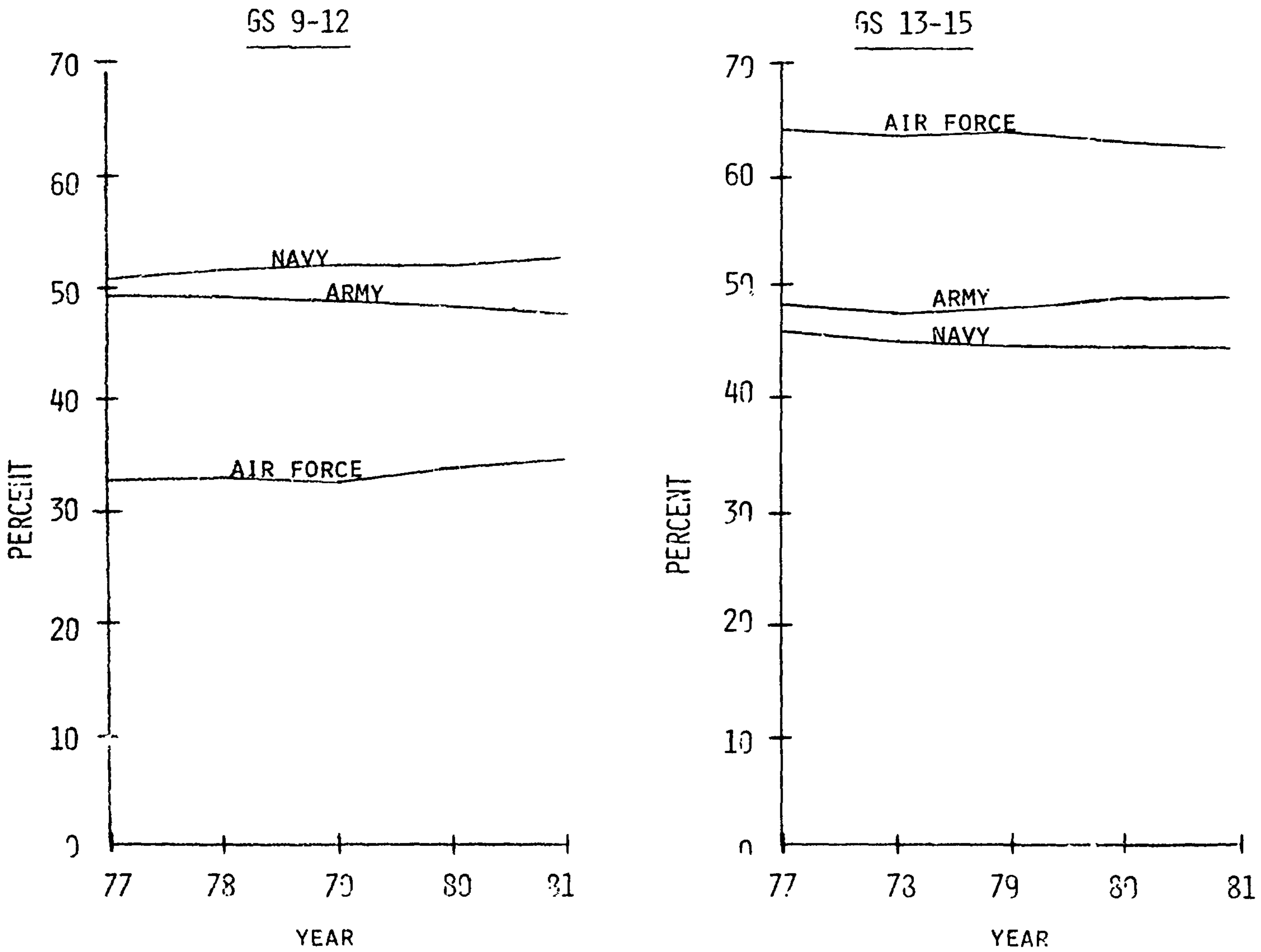




AVERAGE GRADE OF CIVILIAN S&E, BY SERVICE

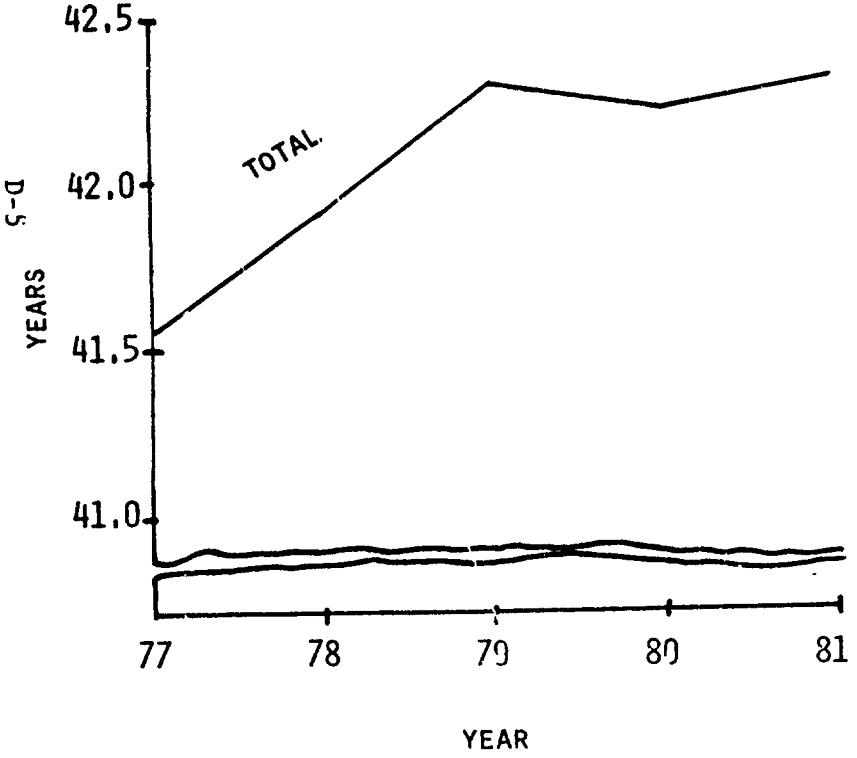


CIVILIAN S&E GRADE DISTRIBUTION, BY SERVICE

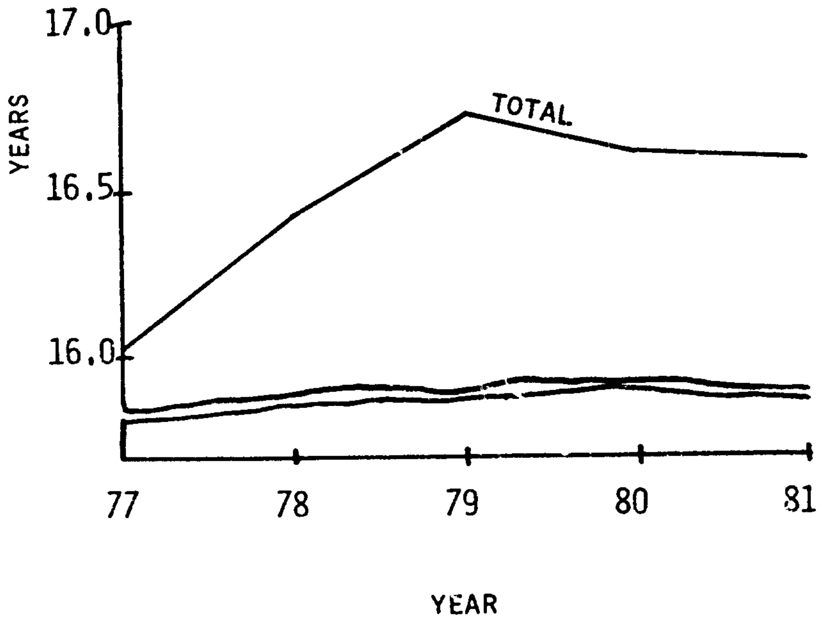


CIVILIAN S&E AVERAGE AGE AND AVERAGE LENGTH OF GOVERNMENT SERVICE

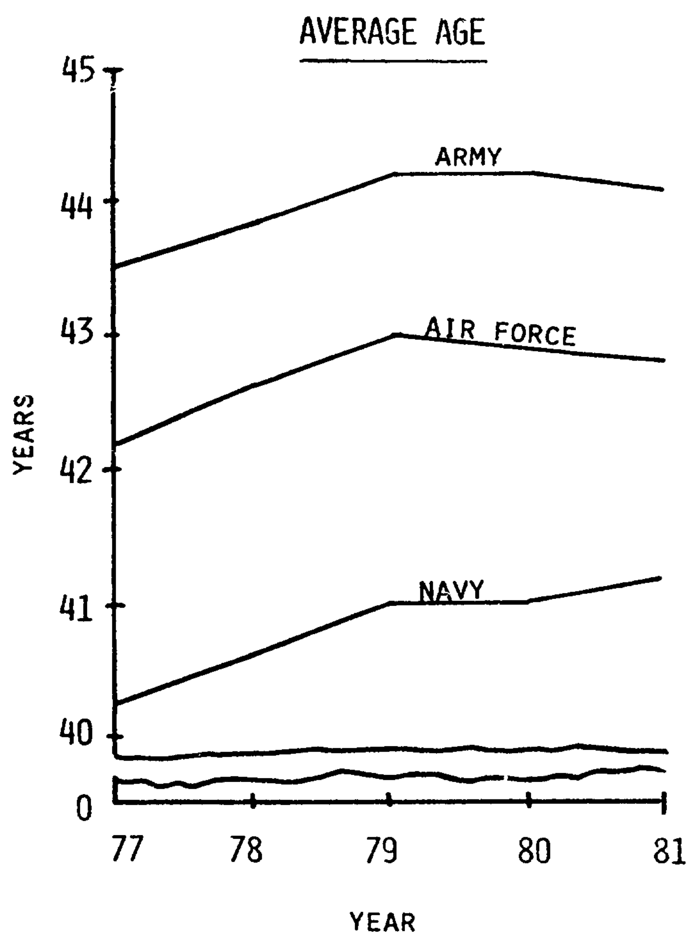
AVERAGE AGE

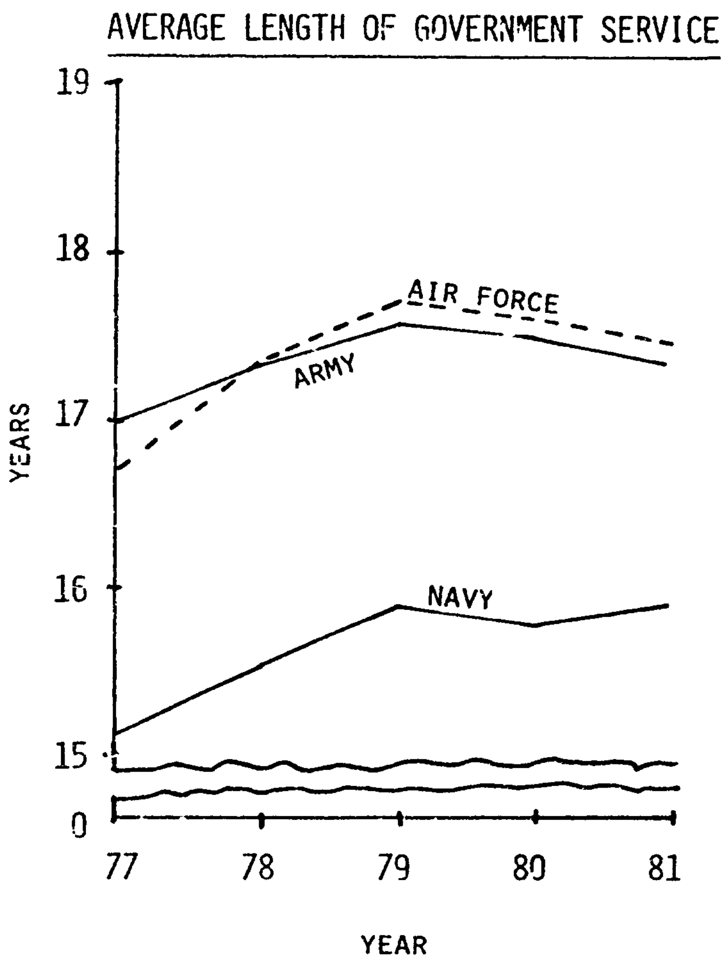


AVERAGE LENGTH OF GOVERNMENT SERVICE

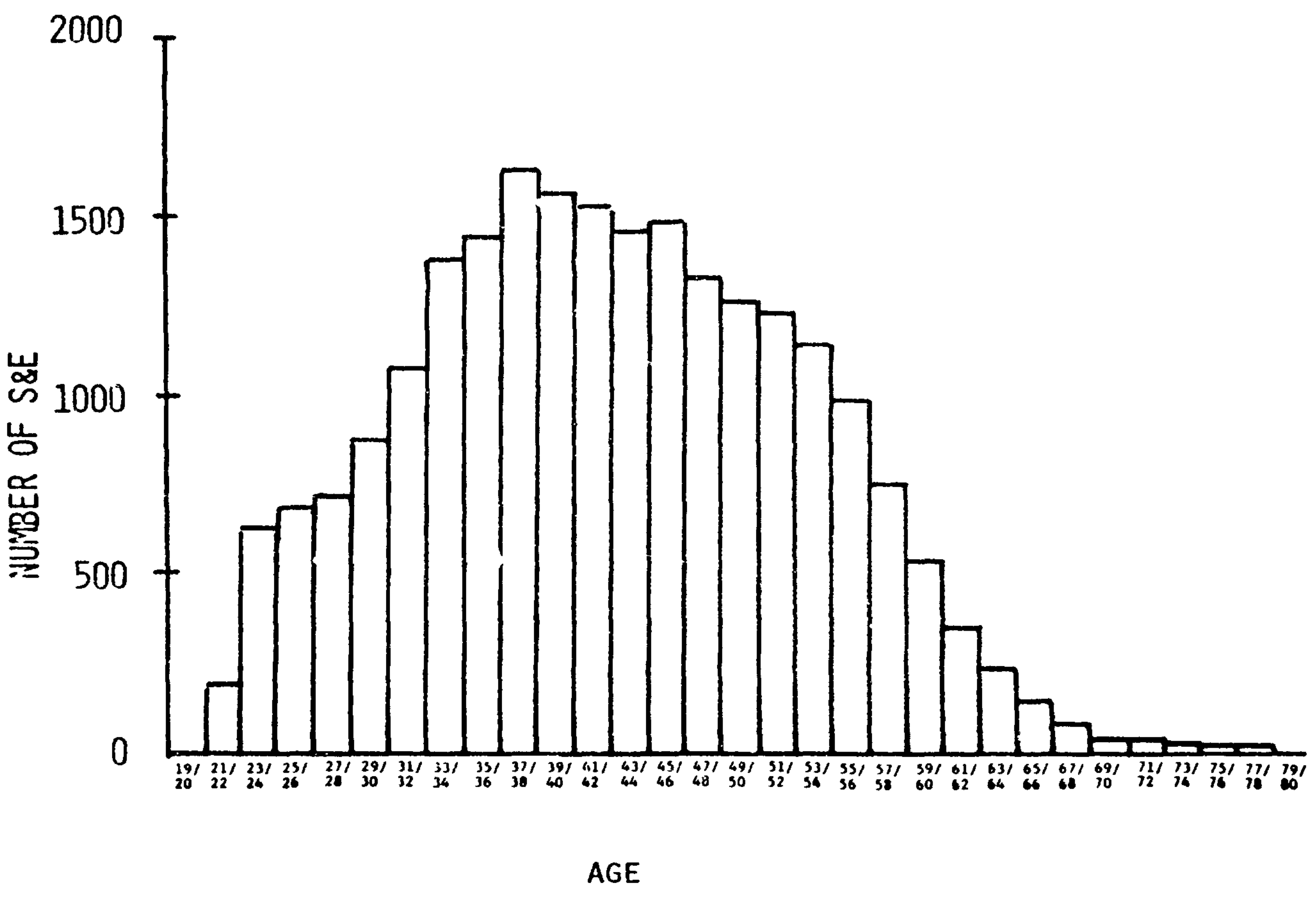


CIVILIAN S&E AVERAGE AGE AND AVERAGE LENGTH OF GOVERNMENT SERVICE, BY SERVICE

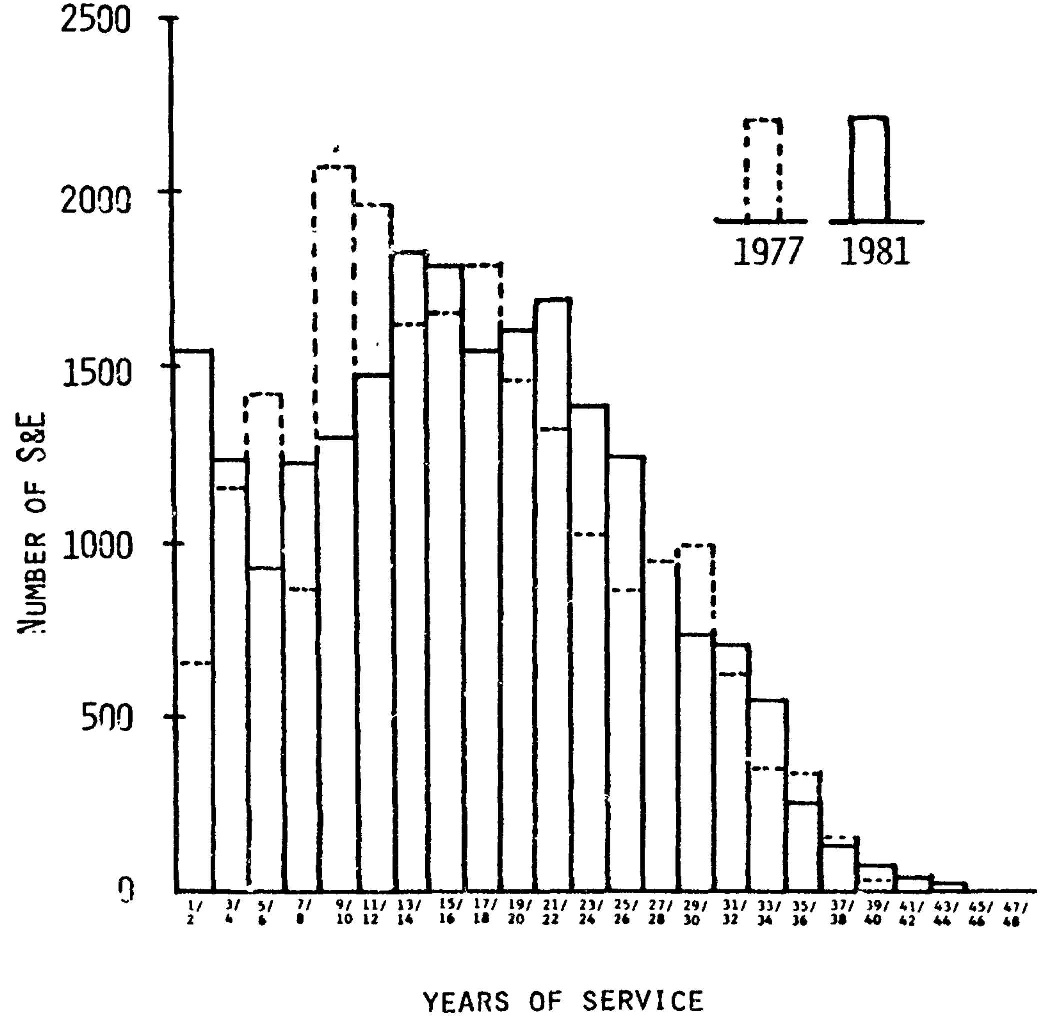




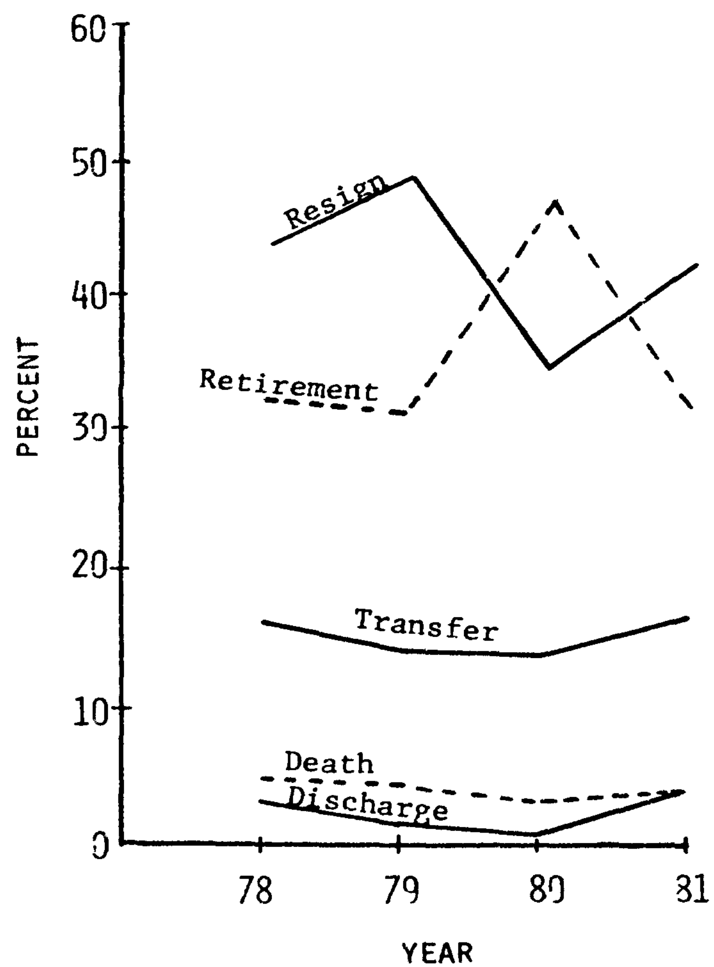
CIVILIAN S&E AVERAGE AGE DISTRIBUTION, 1981



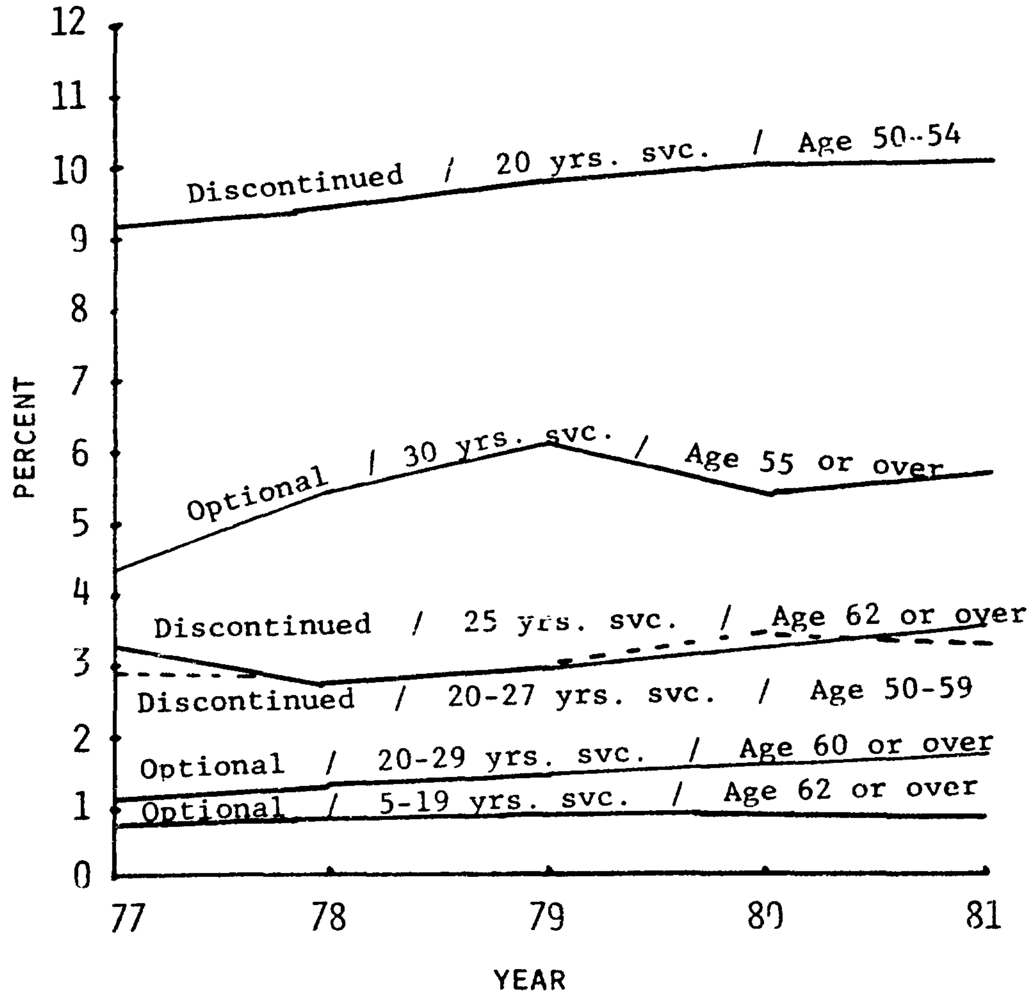
CIVILIAN S&E LENGTH OF GOVERNMENT SERVICE DISTRIBUTION, 1977 AND 1981



REASONS FOR SEPARATION FOR CIVILIAN S&E



CIVILIAN S&E RETIREMENT ELIGIBILITY

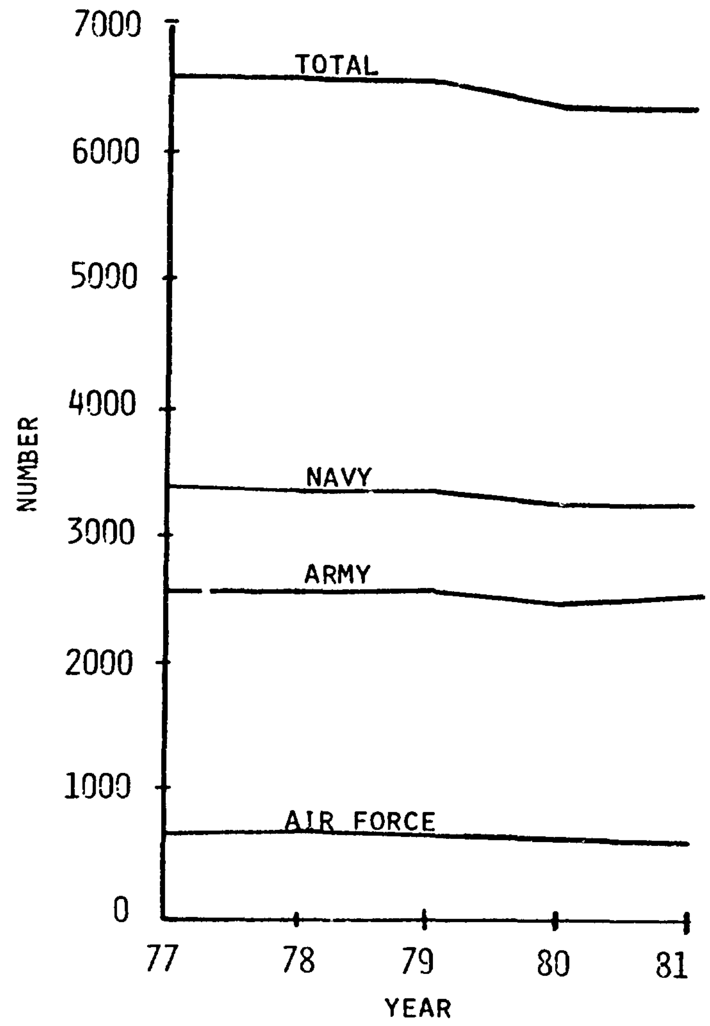


MILITARY SCIENTISTS AND ENGINEERS

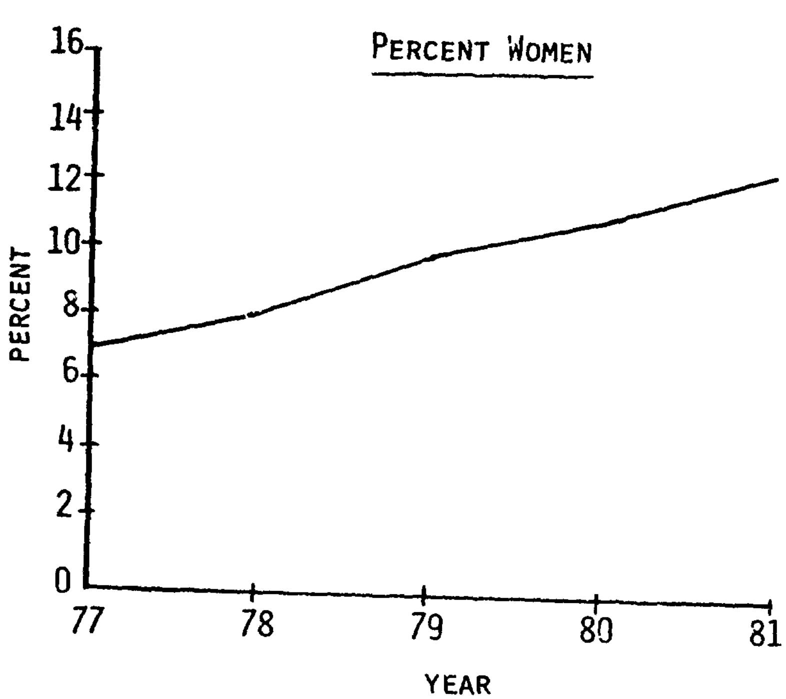
(SEPTEMBER 30)

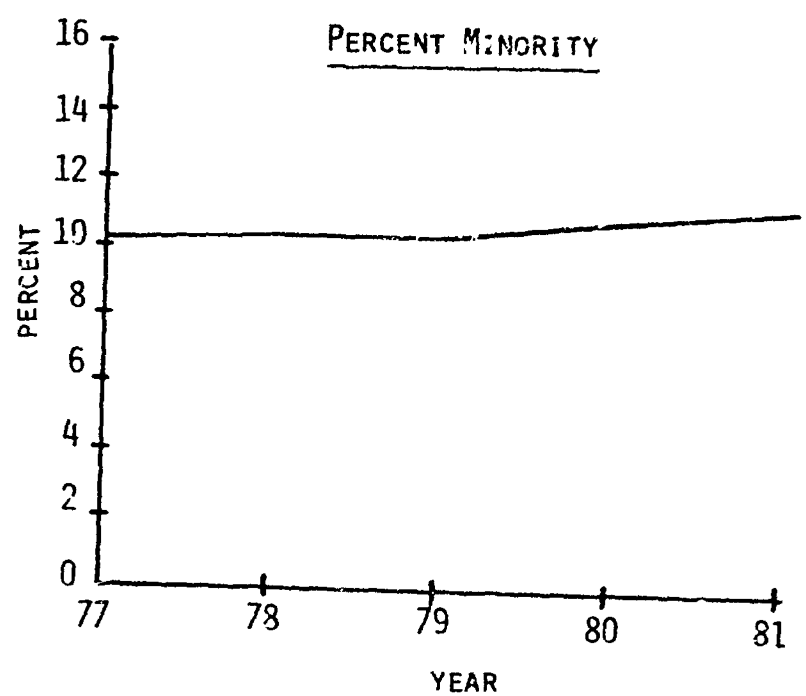
	ARMY			NAVY			AIR FORCE			TOTAL		
GRADE	1979	1980	1981	1979	1980	1981	1979	1980	1981	1979	1980	1981
WARRANT	6	16	18	2	4	5	0	0	0	8	20	23
O-1	16	8	10	3	4	9	218	214	223	237	226	242
O-2	34	20	15	10	7	3	185	207	218	229	234	236
O-3	132	146	150	67	60	52	464	446	407	663	652	609
O-4	104	89	94	74	92	77	192	191	191	370	372	362
O-5	77	83	83	56	56	49	165	156	155	297	295	287
O-6	38	47	59	11	15	19	82	82	84	131	144	162
TOTAL	407	409	429	223	238	214	1305	1296	1278	1935	1943	1921

TOTAL CIVILIAN TECHNICIAN EMPLOYMENT IN DOD LABS

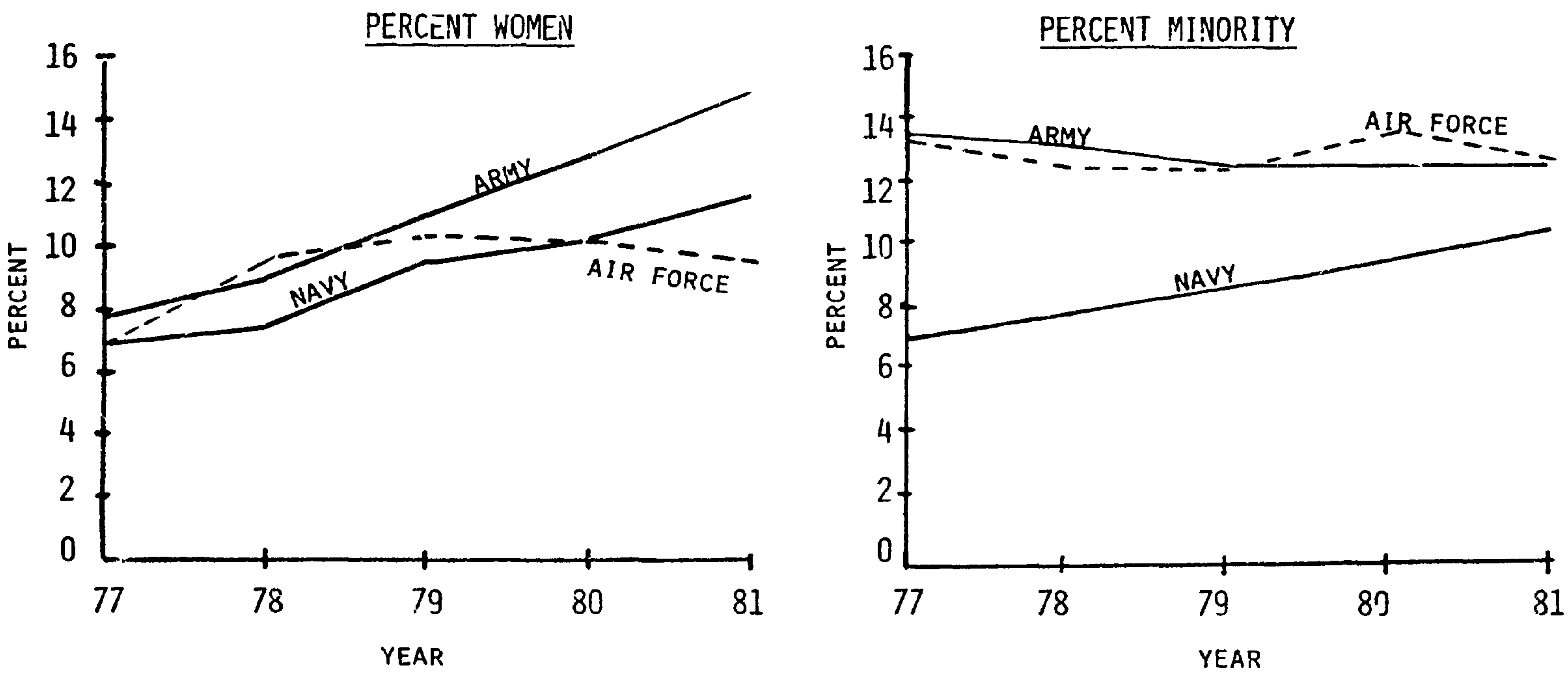


CIVILIAN TECHNICIAN WOMEN AND MINORITY EMPLOYMENT

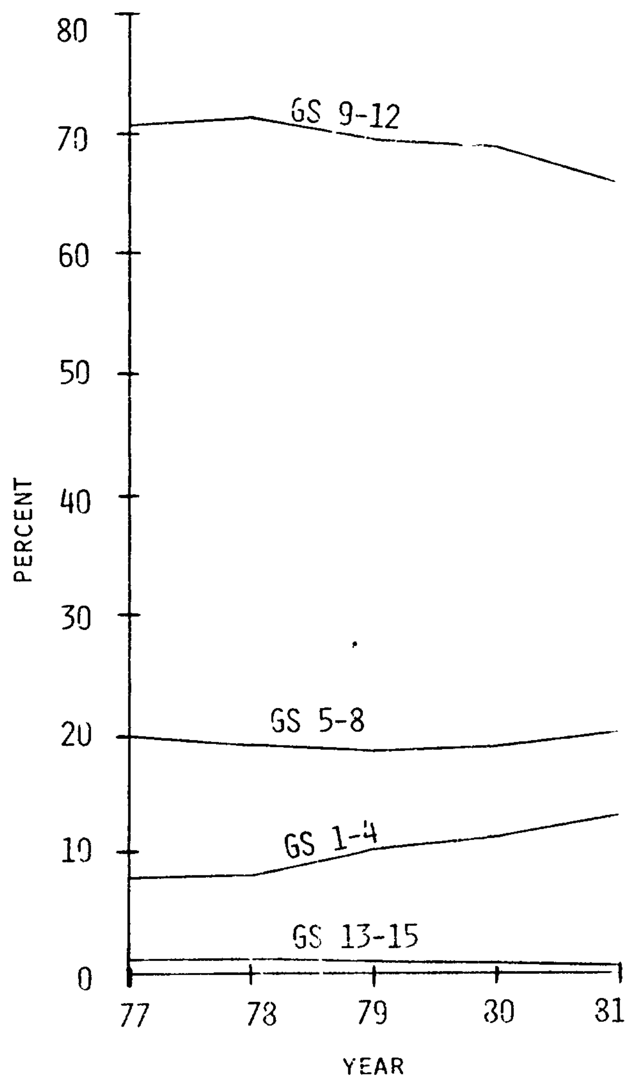




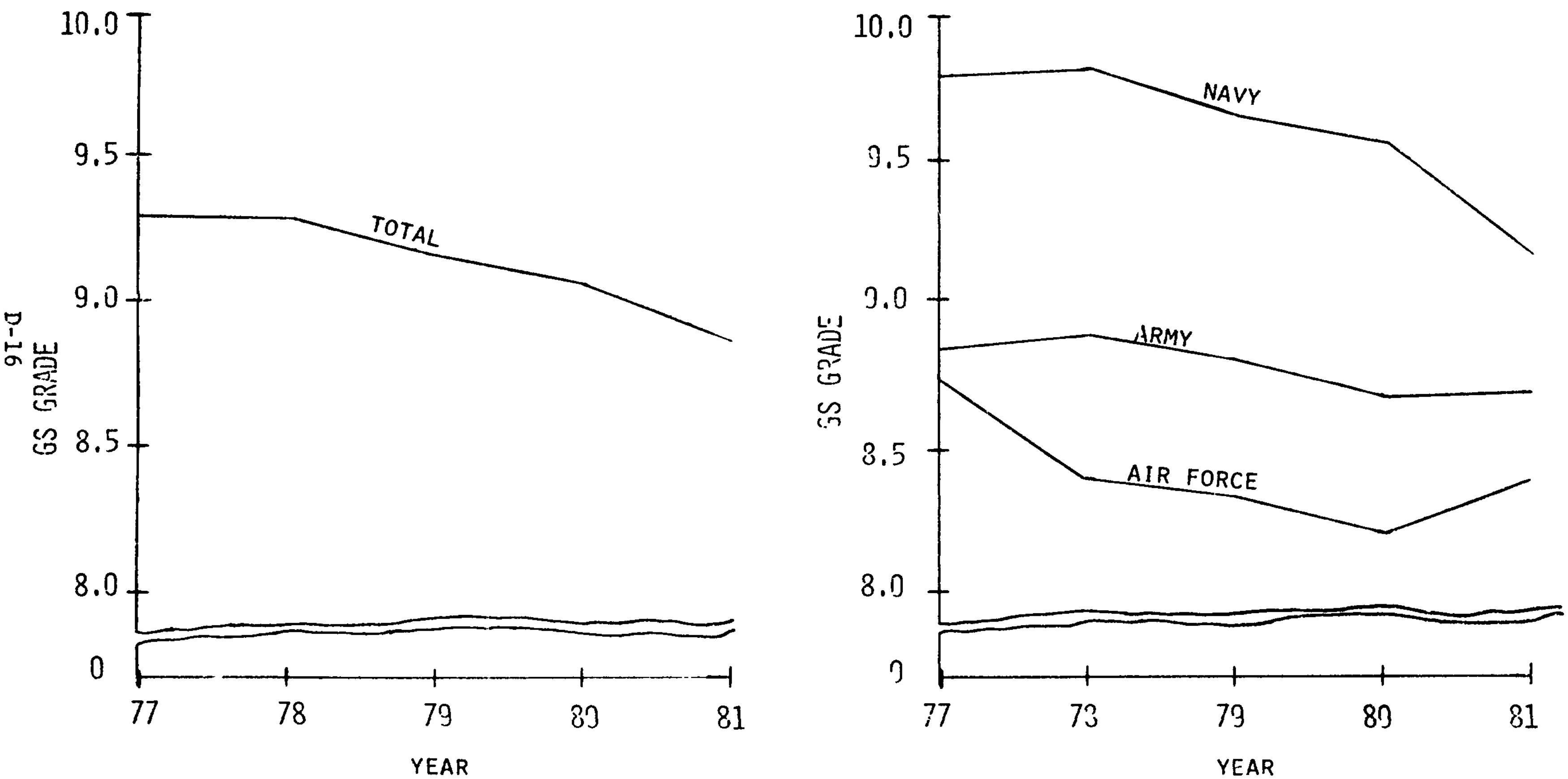
CIVILIAN TECHNICIAN WOMEN AND MINORITY EMPLOYMENT, BY SERVICE



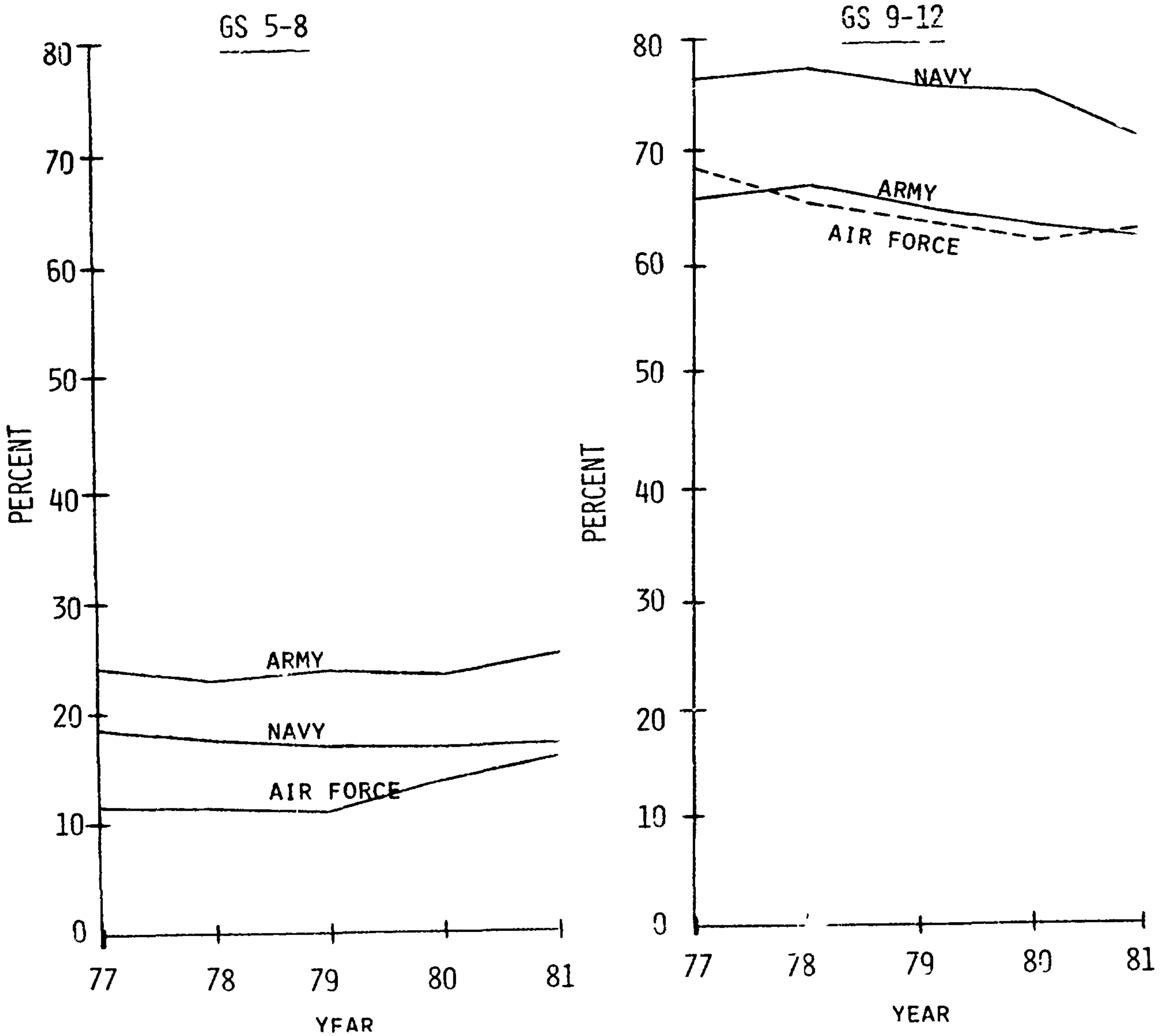
CIVILIAN TECHNICIAN GRADE DISTRIBUTION



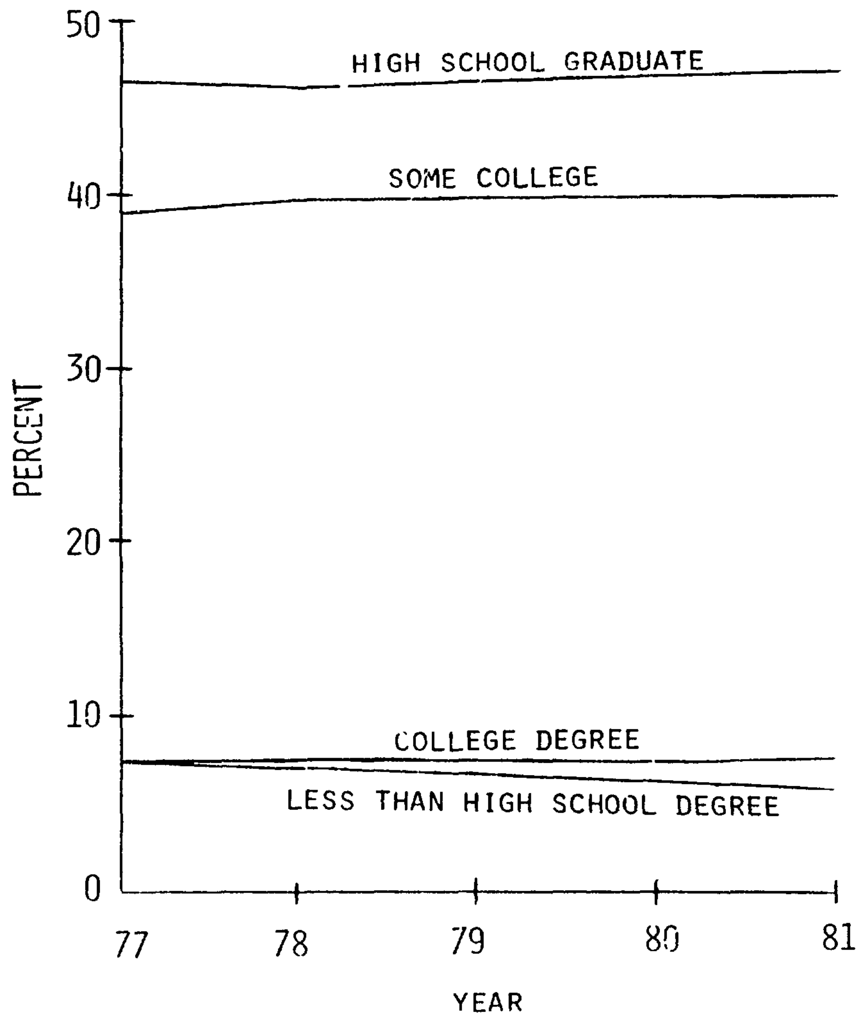
AVERAGE GRADE OF CIVILIAN TECHNICIANS, BY SERVICE



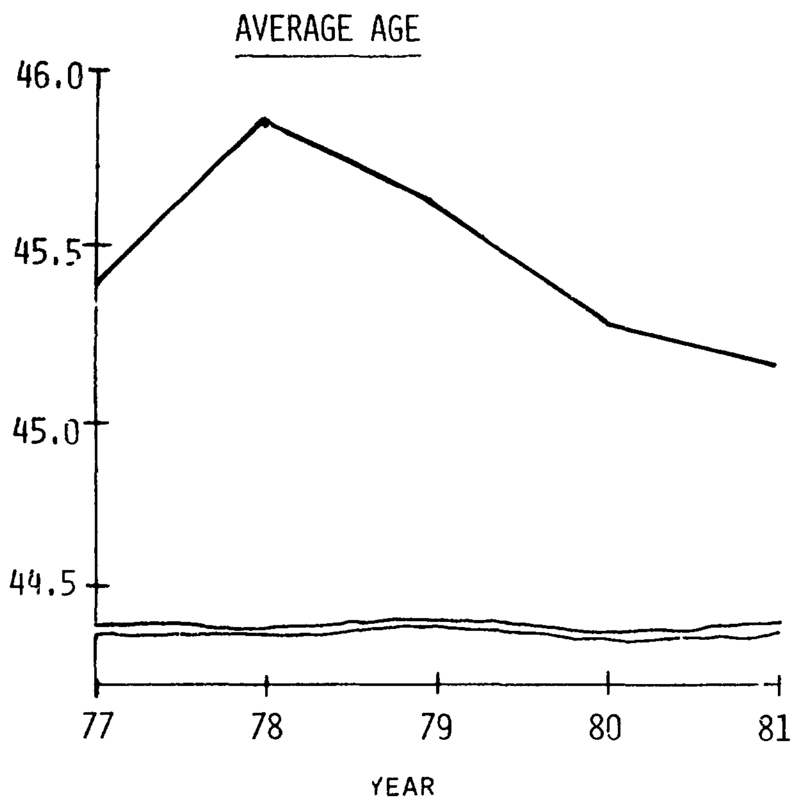
CIVILIAN TECHNICIAN GRADE DISTRIBUTION, BY SERVICE

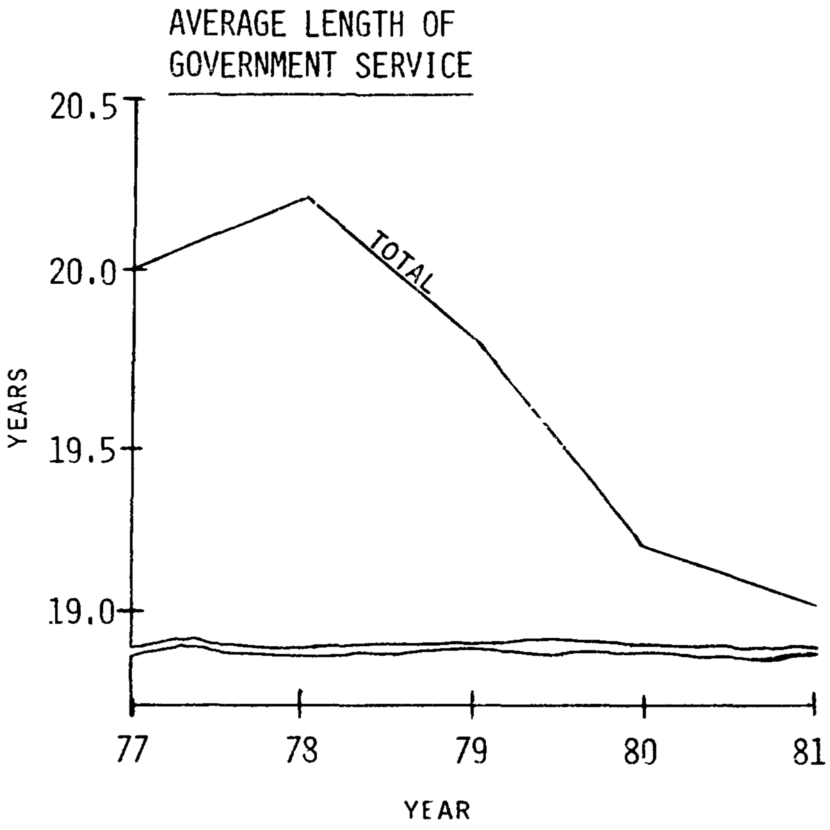


CIVILIAN TECHNICIAN EDUCATION

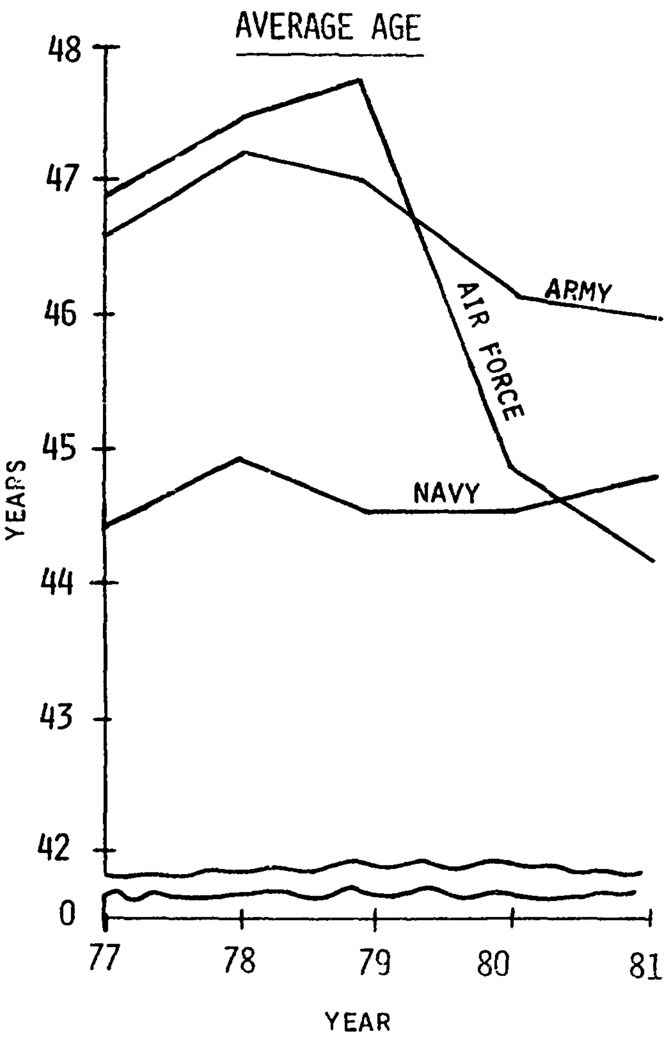


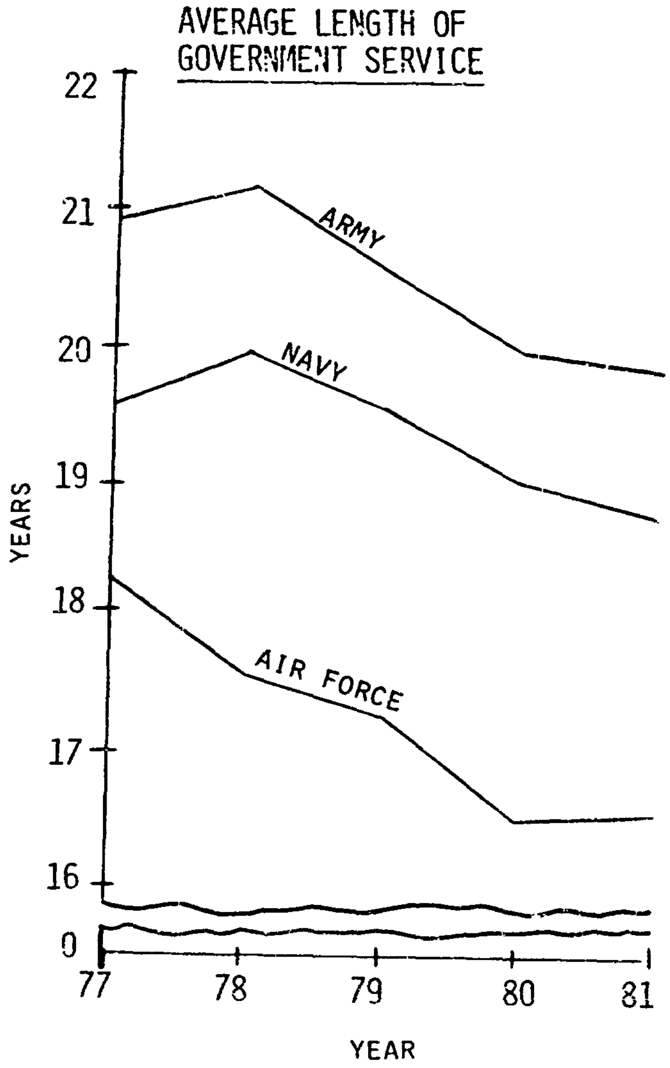
CIVILIAN TECHNICIAN AVERAGE AGE AND AVERAGE LENGTH OF GOVERNMENT SERVICE



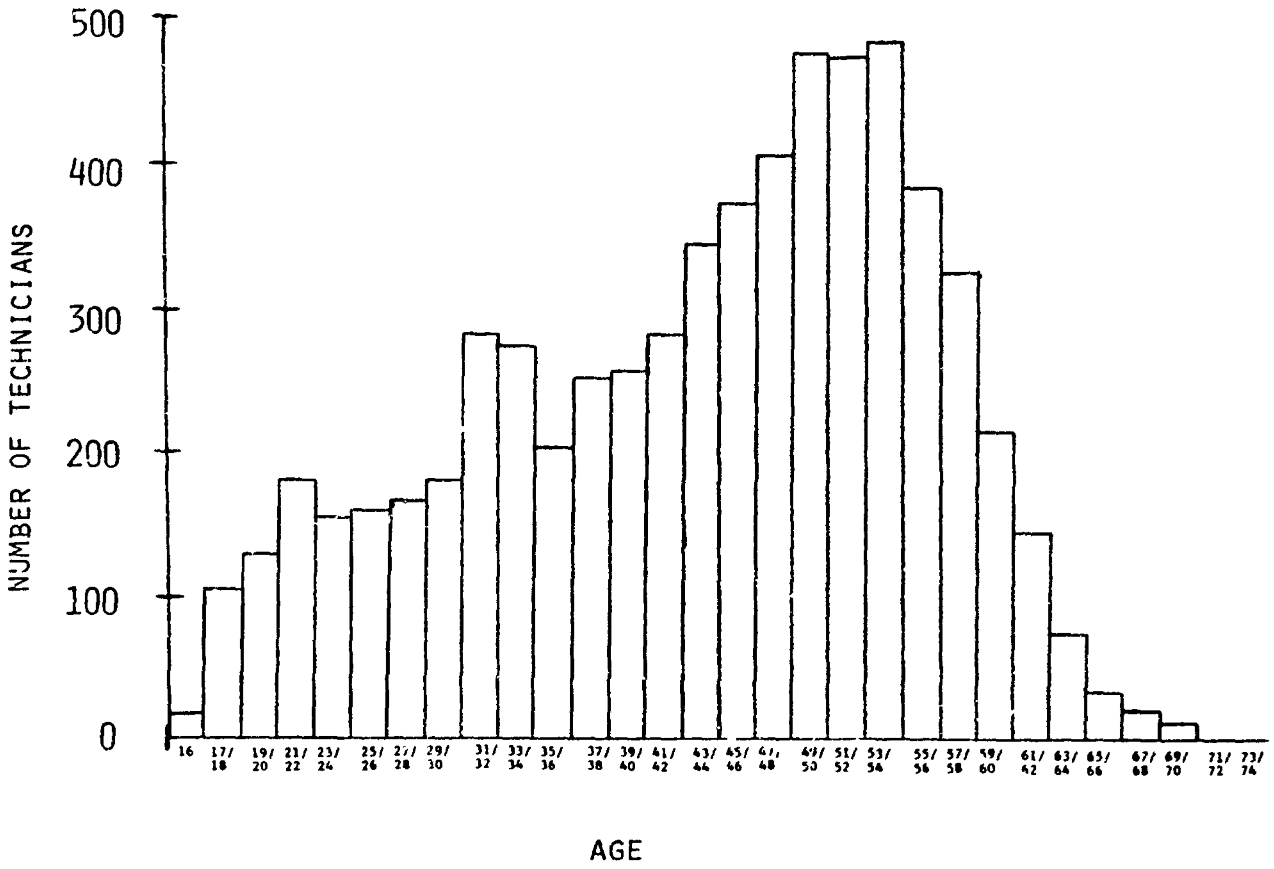


CIVILIAN TECHNICIAN AVERAGE AGE AND AVERAGE LENGTH OF GOVERNMENT SERVICE, BY SERVICE

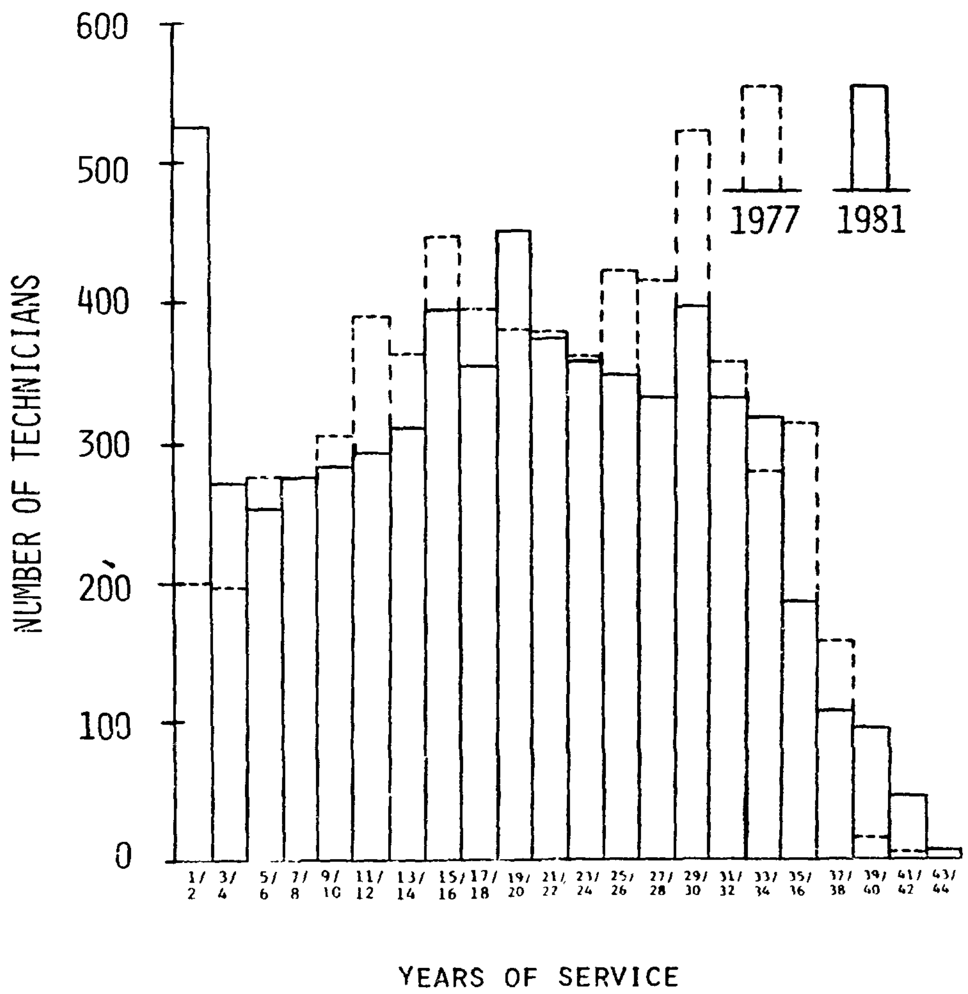




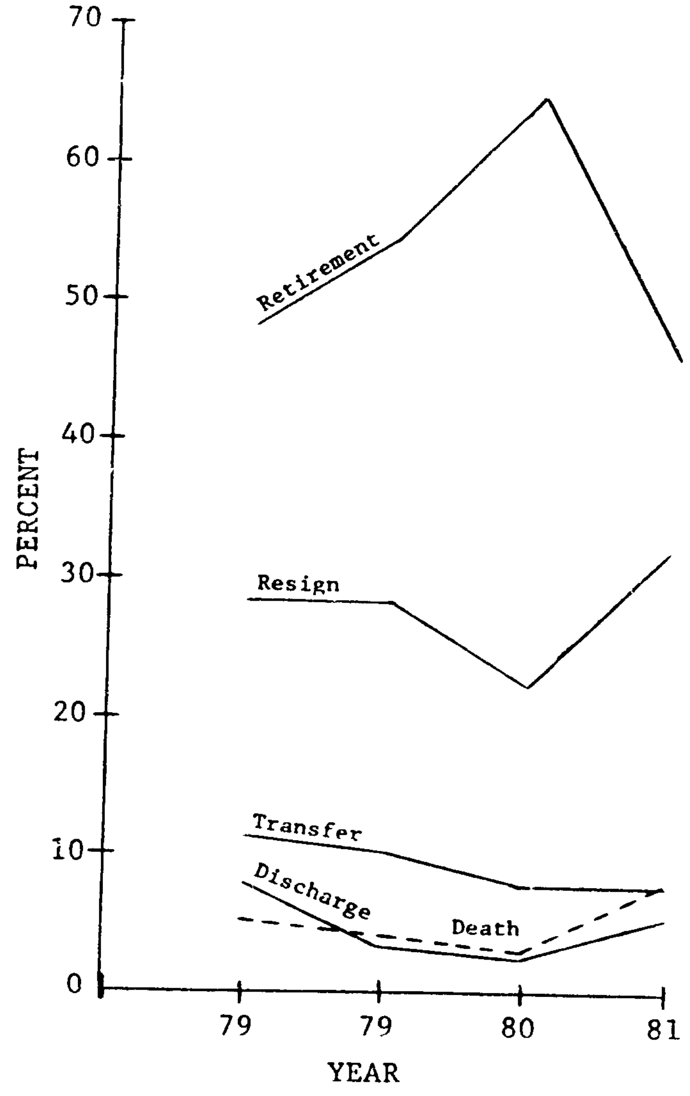
CIVILIAN TECHNICIAN AVERAGE AGE DISTRIBUTION, 1981



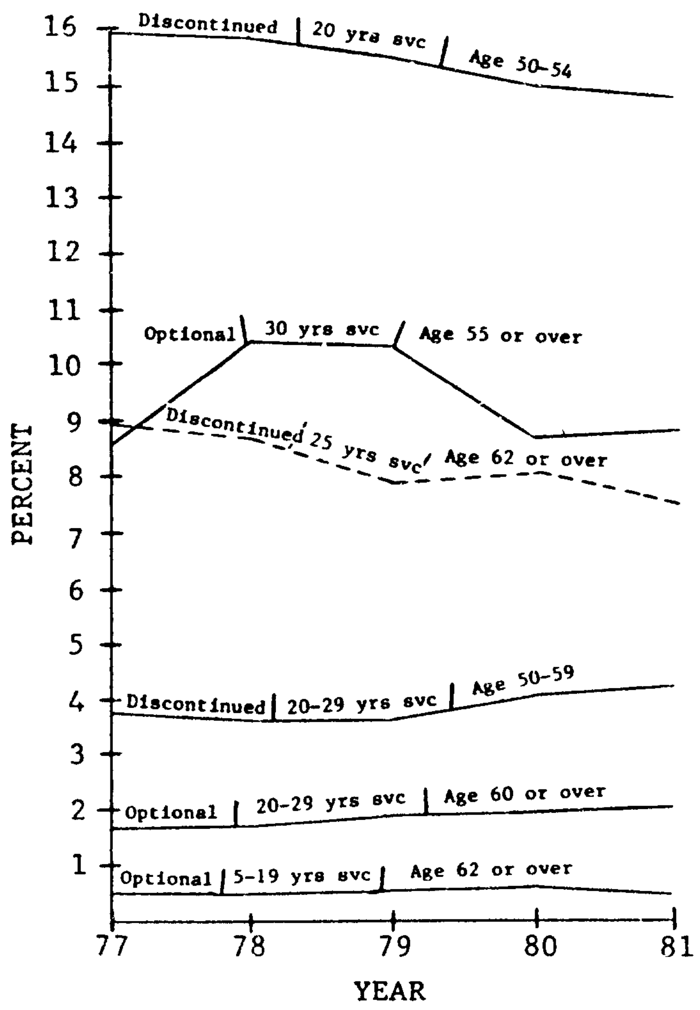
CIVILIAN TECHNICIAN LENGTH OF GOVERNMENT SERVICE DISTRIBUTION, 1977 AND 1981



REASONS FOR SEPARATION FOR CIVILIAN TECHNICIANS



CIVILIAN TECHNICIANS RETIREMENT ELIGIBILITY



APPENDIX E

SUMMARY OF RELEVANT PERSONNEL PROGRAMS

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SUMMARY OF RELEVANT PERSONNEL PROGRAMS

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
U S Army, Fort Gordon, Augusta, Georgia	The Plan for the National Science Center for Communications and Electronics Undated	1980s	General Public	Promotional Brochure	The National Science Center for Communications and Electronics is an industry, academic, and government partnership designed to promote science, educate and train students, help recruit students into the fields of communications and electronics, educate and train military personnel in the sciences of communications and electronics Support is expected from the U S Army at Fort Gordon, the U S Army Signal Corps Association, and the Foundation for the National Science Center for Communications and Electronics The Center will be located in Augusta, Georgia and will be completed in September of 1986 at a cost of $400,000 It will be primarily a museum and visitor center

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
The Armed Forces Communications and Electronics Association	The Partnership for the Development of National Engineering Resources An Initiative Plan Undated	1980s	Junior High School Students Through College Undergraduates	Promotional Brochures	The Partnership has a goal of establishing a program to produce the number of engineers required to meet the nation's needs The initiative plan is a three-year program to be implemented in four phases. The plan involves AFCEA, industry and ROTC The capital operating expenses and resource materials for the program will be provided by the academic institutions, industry, and the public sector The initiative plan has the following objectives establish a relationship between ROTC and professional organizations whereby industry may have a direct link to high school/college students to foster engineering careers, through ROTC, stimulate and acquaint students with the advantages of being an engineer, expand ROTC recruitment efforts by increased DOD participation, influence the expansion of university resources devoted to the education of engineering students, foster industry summer job programs for qualified high school/college students, promote the change of military service career patterns as an enticement for retention, establish industry funded university chairs that support communications-electronics disciplines The initiative plan is expected to be implemented by 1983.

Name of Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
National Science Foundation	Federal Programs For Science And Engineering Education May 1981	1979 and 1980	Science And Engineering Programs	Report	In FY 79, NSF provided between 16% and 24% of total federal funding (estimated between $254 2 million and $367 2 million) for science and engineering education in colleges and universities In FY 79, NSF accounted for 16% of total federal support of $3 8 billion for R&D in colleges and universities In FY 79, NSF accounted for somewhat less than 3% of total federal support of $30 1 billion for R&D and R&D plant That year, NSF accounted for less than 1% of the total federal support of $14 1 billion for education In FY 79, NSF was the largest single federal source of fellowship, traineeship, and training grant support in mathematics/computer science (82%), environmental science (44%), and in economics, linguistics, and political science In FY 79, NSF accounted for over 89% of the total support for facilities and equipment for instruction in science and engineering Support for graduate students in NSF research grants dropped from 1[illegible] 1% in 1967 to 9 8% in 1978, although numbers of graduate students supported increased Federal support for secondary education has been minimal About $5 0 billion of his $6 0 billion spent by the federal government in FY 79 for higher education (excluding R&D support to colleges and universities) is for student support, not institutional support

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
You & Youth, Vol 3, No 10, Vocational Foundation, Inc October 1981	Norwood, MA Raytheon Data Systems Supports 4-School Project, Helps Teachers Design Computer Course/ Contributes Equipment	1976-1981	High School Teachers and Students	Article	Four Massachusetts high schools are benefiting from a unique business-education project sponsored by Raytheon Data Systems Raytheon designed and supported a training program for teachers in current technology and in curriculum design Six math teachers with some computer experience were hired by Raytheon for 8 weeks at full pay to participate in an intensive computer science course Raytheon then donated and installed $80,000 worth of equipment in each of the 4 schools for implementation of the teacher-designed computer curriculum and provided ongoing assistance to the participating teachers The company then tested a co-op education program, hiring a small number of students who completed the school computer courses for paid work experience Of 431 students who have taken the course in the last two years, 197 enrolled in college, 56 planned to major in engineering, 79 will study computer sciences, and 54 favor business administration

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
You & Youth, Vol 3, No 10, Vocational Foundation Inc October 1981	Project Access Private Industry Enters the Classroom Through Paid Summer Internships for Teachers	1977-1981	High School Teachers	Article	A symposium series sponsored by Raytheon and Boston University School of Education brought together industry and education representatives to discuss the relationships that should exist between schools and future employees, identity specific programs that might be develped with Raytheon or other companies in the community, determine how these programs might be designed and implemented A total of 120 educators participated To date, Raytheon has employed 43 teachers in short-term and full-time summer jobs Weekly seminars with functional vice-presidents and managers gave teachers a broader exposure to the plant Through Project Access more than 1 000 students have received additional exposures to the private sector through planned tours, guest speakers, and career days

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
Northwest Regional Educational Laboratory	Experience-Based Career Education	1972-1981	Secondary and Post-secondary School Students	Information Brochure	Experience-Based Career Education (EBCE) is a fundamentally different type of education for secondary and post-secondary students. While students in traditional programs attend classes all day, EBCE students spend a major portion of their time on learning projects in the community. Activities are tailored to individual student needs, abilities, learning styles, and goals. Students are guided in their learning by ongoing relationships with working adults in laboratories, offices, factories, shops, hospitals, schools, courtrooms, and studios. The program started in the Fall of 1972 in Tigard, Oregon
National Research for Geosciences Laboratories, Inc	Program Plan for the Development of Minority Students for Industry 28 Aug 1981	1981-1983	Minority Science and Engineering College Students	Program Description	NRG Labs, Inc., a minority-owned organization is comprised of a group of leading scientists and engineers who, collectively, have over 250 years of professional experience in both academic and industrial environments. Its objectives are: to obtain contract awards for specialized services in high technology research in materials science and systems engineering, apply their technical and management skills to the further development and preparation of minority college students for scientific and engineering roles in industry. It runs a two-year, five-phase program whose objectives are to assess industries' needs for scientists and engineers and recruit students to meet those needs, to provide tutelage/facilities to these students with experienced minority scientists and engineers as tutors and role models, to provide summer workshop experiences in industry which place minority students in quality, high technology settings, to hold seminars for student familiarization in industrial practices and procedures.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
Ford Foundation	Minorities and Mathematics, A Ford Foundation Staff Paper August, 1981	1980s	Minority Students in Mathematics at All Levels	Staff Report	The entire system of mathematics education in the U S needs radical reform -- in the way mathematics is presented, the number and kind of courses offered, and in the training of teachers, especially in the elementary and high school grades The problem is especially acute with minorities The Ford Foundation has provided an initial grant of $1 1 million to a consortium of six community colleges on the U S -Mexican border, several predominantly black universities, public school districts in various parts of the country, an Ivy League college, a state university, and the American Association for the Advancement of Science Most of the grants are cooperative projects of two or more institutions, and most are planning or initiating programs with an eye to their usefulness and replication in other parts of the country. Many of the projects are seeking support from business and industry Some will work with students and secondary school teachers, others only with students Some focus on the problems of inner-city youths and teachers, others address the special problems of isolated rural areas.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
The National Research Council, National Academy of Sciences	Retention of Minority Students in Engineering 1977	1969-1977	Minority College Students in Engineering	Report	The number of minority students in college engineering increased from 1973 to 1977 The number of graduates did not rise proportionally. The high attrition rate was due to insufficient preparation in mathematics and the physical sciences, inadequate motivation toward engineering as a career choice, lack of adequate financial resources, absence of self-confidence, personal and/or family problems The report discusses the characteristics of successful retention programs at schools which have reported successes. Recommendations are broad-based and generally applicable to all colleges and universities

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National Association of Pre-College Directors	A Program Description Undated	1978-1981	Secondary School Math and Science Students	A Brochure	The National Association of Pre-College Directors (NAPD) is a network of secondary school programs which focus on career choice and preparation in mathematics, science and engineering. The program started in July 1978. Since then, the group of six pre-college program directors meet semi-annually to review program operations, analyze common opportunities and problems, and interact with other groups interested in secondary school programs aimed at increasing the preparation of underrepresented minority students for careers in mathematics, science, and engineering. Programs in the NAPD network have built effective regional staffs that deliver a mix of services which improve the pattern of enrollments in secondary school math and science courses and increase students' interest in pursuing mathematics, science, engineering, and related disciplines at the university level. NAPD receives support from the Alfred P. Sloan Foundation.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
The New York Times June 6, 1981	Minority Engineers Cultivated by Gene I Maeroff	1981	Minority Scientists and Engineers	Article	City College of New York received $2.7 million from the National Science Foundation to establish a center to promote the education of scientists and engineers who belong to minority groups. The effort will involve a center divided into four divisions to deal with graduate training, undergraduate training, elementary and secondary schools, and the community The center will be the fourth of its kind established by the federal government, which, since 1978, has created similar enterprises for the southeast at Atlanta University, for the southwest at the University of New Mexico, and for Puerto Rico at the University of Puerto Rico As a consequence in the 1980-81 academic year, there were 16,181 blacks and 9,043 hispanics enrolled in undergraduate engineering programs throughout the country

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
Department of Education	Minority Institutions Science Improvement Program Guide for the Preparation of Proposals, Fiscal Year 1981 Undated	1981-1982	Secondary and College Science and Engineering Students	Program Announcement	With the passage of the Department of Education Organization Act of 1979 (PL 96-88), responsibility for the Minority Institutions Science Improvement Program (MISIP) was transferred from the NSF to the Department of Education. A total of 233 MISIP awards have been made since the program's inception in FY 1972 totaling over $43 million. It is anticipated that approximately $5 million will be made available from the Department of Education for FY 1981 program support Objectives of MISIP are to assist institutions to improve the quality of preparation of their students for graduate work or careers in science, to improve access of undergraduate minority students to careers in the sciences, mathematics, and engineering, to improve access for pre-college minority students to careers in science and engineering through community outreach programs conducted through eligible minority colleges and universities. Support is primarily in the form of grants
National Aeronautics and Space Administration	Resident Research Associateships; Postdoctoral and Science Postdoctoral 1980	1980	Postdoctoral Scientists and Engineers	Announcement	The National Research Council of the National Academy of Engineering conducts the Resident Research Associateship Programs in cooperation with a number of selected federal laboratories and research organizations Some 16 other U.S. government research agencies cooperate in the program. Objectives are to provide postdoctoral scientists and engineers of unusual promise and ability opportunities for research on problems which are compatible with the research interests of the sponsoring laboratories, to contribute thereby to the overall research effort of the federal laboratories Awards are in the form of stipends of approximately $18,000 for one calendar year.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
National Science Foundation	NSF Funds 402 Research Apprenticeships for Minority High School Students Press Release 81-39 26 Apr 1981	1981	Minority High School Students	Press Release	NSF awards were made totaling about $950,000 that will enable 402 minority high school students to participate in advanced science and engineering research projects at colleges and universities. The awards are NSF's contribution to the Research Apprenticeships for Minority High School Students Program initiated in October 1979 by the White House to stimulate the interest of talented minority students in science and engineering Twenty-nine colleges and universities in urban areas with substantial minority populations were selected for the awards These institutions will administer the NSF grants Each grant provides a $900 stipend for summer work and a $450 stipend for academic year activities, $800 to the grantee institution to cover costs associated with the program, and a $300 honorarium to the high school teacher who will supervise the student's activities

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House of Representatives	A Proposed Bill Introduced in the 97th Congress, 1st Session, H R 5254 16 Dec 1981	1982	Engineering, Scientific, and Technical Manpower	Proposed Legislation	The bill proposes to provide a national policy for engineering, technical, and scientific manpower, to create a national coordinating council on engineering and scientific manpower, and for other purposes The bill calls for a program to be coordinated by the council and reviewed by the Office of Science and Technology Policy in the Executive Office of the President. Federal government agencies shall take actions to identify the technical, engineering, and scientific human resource needs of the nation, establish and maintain the necessary means for continually assessing the short and long-term technical, engineering, and scientific human resource needs and to provide for the programs to meet those needs. Federal funding for such activities and programs shall be made available under the normal processes of the Congress

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
National Science Foundation	Planning Session Federal Interest in Minority Participation in Science and Engineering 9 Feb 1982	1982	Minorities and Women Scientists and Engineers	Proposals	The document contains proposals of the National Science Foundation to promote the full participation of minorities and women in science and engineering. On September 15, 1981, President Reagan signed an Executive Order to strengthen the capacity of historically black colleges and universities to provide quality education The NSF is participating in the development of a federal program to achieve a significant increase in participation by these institutions in federally-sponsored programs. The primary focus of the foundation's activities is the performance of research carried out by the scientists and engineers in the nation's colleges and universities. Data are supplied on minority-focused programs, employment, and enrollments in the nation's primarily black universities

APPENDIX F
ANNOTATED BIBLIOGRAPHY

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American Defense Preparedness Association	Will Shortages Impact Preparedness and National Security 28 Dec 80	Present	Engineers/ Scientists for the 1980s and Beyond	Report and a Seminar	Primary and high schools have decreased emphasis on disciplined subject matter required for engineering sciences in college Colleges and universities cannot encourage engineering studies because they cannot obtain sufficient faculty Shortfall is estimated at 2,000 nationally Quality of engineering programs in academia is severely degraded by the use of obsolete equipment housed in archaic facilities Average ages of equipment in engineering schools exceeds 14 years. Technology change doubles every 4 to 5 years Lead times for expanding capacity in academic plant are on the order of 8 to 10 years Considerable portion of U S engineering school capacity is utilized for training foreign students who return to their countries of origin after graduation The academic plant which produces scientists and engineers is operating at capacity and is turning away large numbers of applicants.
U.S. House of Representatives Committee on Science and Technology	Shortage of Scientists and Engineers 6/7 Oct 81	Present-1990	Scientists and Engineers	Testimony	John Geils of American Society for Engineering Education is leading a two-year project to solve engineering college faculty shortage problem. Funded by 8 major corporations. BLS manpower study predicts 16,000/year shortfall of engineers during 1980-1990. Exxon Education Foundation will provide $15M to 66 colleges and universities for 100 teaching fellowships and 100 salary grants for engineering faculty.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
U.S. Department of Labor, Bureau of Labor Statistics	Occupational Outlook Handbook, March 1980	1978-79	Engineers	Handbook	Data on numbers of engineers in various disciplines with salary data.
Oil and Gas Journal	Career Opportunities in the Oil Industry, August 1975	1975-1985	Petroleum Engineers	Survey Report	The oil industry's need for college graduates is still great. Aspects of employment within the industry are discussed such as specialties in shortest supply, demand for engineers, median salaries, industry's overall manpower requirements.
National Planning Association/ National Science Foundation	Study of Manpower Requirements by Occupation for Alternative Technologies in the Energy-Related Industries, U.S. Vol. III	1970-1990	60 Occupations Involved in Construction and Maintenance of Energy Facilities	Industry Surveys	Direct labor usage coefficients for energy activities addressed in Project Independence Report of November 1974.
National Science Foundation	Engineering Colleges Report 10% of Faculty Positions Vacant in Fall 1980 Nov. 1981	1980	Faculty of Engineering Colleges	Survey	Results of survey of 181 engineering colleges. Of the 16,200 full-time engineering faculty positions, about one-tenth were vacant. Two-fifths of these had been vacant at least one year. Engineers from other countries have helped to fill the shortage of faculty

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
National Science Foundation	Science and Engineering Faculty with Recent Doctorates Fell to one-fifth of Total in 1980 Oct. 1981	1980	Science and Engineering Faculty	Survey	The proportion of recent doctorates (those holding their degrees for seven years or less) on the full-time faculty of S&E departments in Ph D-granting institutions was 21% in 1980, down from 28% in 1974 and 39% in 1968. Overall switches to nonacademic employment accounted for one-fifth of departures Most extensive in engineering, amounting to 28% of exits (only 1% to 2% of faculty).
The New York Times	View From the Lab Prospects Are Glum for Engineers 23 Dec. 1980	1980	Engineering	Article	Engineering laboratory equipment at many universities is outmoded (of WW II vintage) The nation has permitted its engineering schools to erode Industry is luring seasoned professors away from colleges with high salaries. Engineering enrollments are up. Capacity is strained Deans are asking the federal government to provide scholarships to produce 1,000 additional Ph.D.s annually. Various engineering groups have estimated there is a national faculty shortage of 2,000 professors.
International Business	A Bargain For the U.S. in High-Tech Engineers 20 Apr. 1981	1981	High Technology Engineers	Article	Electronics companies are establishing research and development centers in Israel due to a shortage of specialized, highly trained engineers

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
American Council on Education National Science Foundation	Recruitment and Retention of Full-Time Engineering Faculty, Fall 1980 Oct. 1981	1980	Engineering Faculty	Report	As of fall 1980, there were approximately 16,200 permanent full-time engineering faculty positions in the 244 institutions with at least one accredited engineering program. Almost 10% of these positions were unfilled at the beginning of the fall 1980 term, of these, 45% had been vacant since fall 1979 During 1979-80, almost 400 full-time engineering faculty voluntarily left academia for full-time employment in industry, representing 2.7% of the permanent faculty.
National Science Foundation	A Guide to NSF Science Resources Data 1980	1980	Experienced Scientists and Engineers	Survey	Sample questionnaires utilized to maintain the national data base.
National Science Foundation	Science and Engineering Personnel: A National Overview June 1980 NSF-80-316	1976-1980	Scientists and Engineers	Overview Report with Statistical Tables	Begins with an integrated overview of current utilization and supply patterns for all U.S. scientists and engineers, continues with a detailed examination of the status of doctoral scientists and engineers, and concludes with an examination of the dynamics of the S&E labor market -- i.e., the flows into and out of science and engineering.
National Science Foundation	U.S. Scientists and Engineers NSF-80-304 1978	1974-1978	Scientists and Engineers	Detailed Statistical Tables	Data presented are estimates of the 1978 demographic, employment, and educational characteristics of scientists and engineers based on S&E manpower data.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
National Science Foundation	Characteristics of Doctoral Scientists and Engineers in the U.S., 1979 NSF-80-323	1973-1979	Doctoral Scientists and Engineers	Time-Series Tables	Tables present data on the demographic and employment characteristics of the nation's doctoral scientists and engineers
National Science Foundation	Academic Science, Scientists and Engineers Jan. 1980 NSF 81-307	1980	Scientists and Engineers	Detailed Statistical Tables	Tables of statistics on the characteristics of scientists and engineers employed by approximately 2,200 institutions of higher education.
National Science Foundation	Science and Engineering Employment 1970-1980 NSF 81-310 Mar. 1981	1970-1980	Scientists and Engineers	Report of Occupational Trends Based on Statistical Tables	Almost 90% of the increase in S&E employment over the 1970-80 decade was linked to increases in overall economic activity. The distribution of the S&E work force has shifted from engineering into computer specialties. About 80% of the S&E employment growth for engineers occurred between 1975 and 1980. In contrast, the bulk of S&E employment growth for computer specialists occurred in the first half of the decade.
National Science Foundation	Scientists, Engineers, and Technicians in Private Industry 1978-80 NSF 80-320 Oct. 1980	1978-1980	Scientists, Engineers, Technicians	Special Report	Report presents the findings of employment studies based on data from surveys conducted by the Bureau of Labor Statistics for NSF. It encompasses, for the first time, comprehensive and up-to-date employment estimates of scientists, engineers, and technicians by detailed occupational field and industry.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
National Science Foundation	Science and Engineering Education for the 1980's and Beyond Oct. 1980	1980-2000	Secondary School Through Postgraduate Education of Science and Engineering Students	Special Report	Report documents a decline in the general understanding of science and technology among students in U.S. secondary schools. There are current shortages of computer professionals at all degree levels and tight markets at all degree levels in most engineering fields. Engineering and computer departments at universities are having difficulty retaining both junior and senior faculty. Many secondary schools report vacancies for teachers in mathematics and the physical sciences.
Senate of the United States	A Bill to Amend the Internal Revenue Code of 1954 to Provide Tax Incentives for the Training of Skilled Workers in Critical Industries Which Have a Labor Shortage 2 Nov. 1981	1981	Skilled Workers	A Bill	Language amending the Internal Revenue Code to provide subject tax incentives to industry for training skilled workers.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
West Virginia University Alumni Association	The Crisis in Engineering Education August 1981	1980-1985	Engineering Students	Article	Refers to a national crisis of undercapitalized, underfunded engineering education in U S universities Accumulated budget shortfall of about $1B in engineering schools at beginning of the 1980s. Expect 30% of faculty positions to be unfilled by 1985. The number of doctoral graduates in engineering fell 30% from 1972 to 1980. In 1980 nearly half of the 2,750 new Ph D s in engineering were foreign nationals. American engineering students are being taught by increasing numbers of foreign-born faculty who do not fully understand U.S. industry and culture and who cannot communicate well with their students. Labor estimates of 17,000 unfilled entry-level engineering jobs in 1980 are stated. Due to constraints on state and federal budgets, industry will be asked to provide a substantial portion of the funding for engineering education, equipment, and facilities. But it will be 1990 or later before the U.S. engineering education system will be adequate to fill national needs.
Government Executive Vol 12, No. 5 May 1980	Military R&D The Worst Shortage is of Trained, Skilled People May 1980	1979	Engineers	Article	In 1979, about 50,000 engineers were graduated from U.S. colleges and universities, half of them were foreign students. In 1959, the Soviet Union graduated 75,000 engineers, almost twice that of the U S. that year. Ten years later, the Soviets graduated 190,000 engineers, almost four times the U.S. total. In 1979, they graduated 300,000 engineers -- six times as many as the U.S. did.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
National Science Foundation, Division of Science Resources Studies	Current Labor Market Conditions for Scientists and Engineers 13 Nov. 1981	1981	Scientists and Engineers	Bulletin of Survey Results	Computer specialties are the most frequently mentioned occupation group experiencing shortages Electrical, electronic, industrial, and petroleum engineers are also in short supply by some employers. Academic institutions are reporting shortages of faculty in computer sciences and most engineering fields. High salary offers by industry lure faculty from academic careers. Nuclear, mechanical, and aeronautical engineering, physics, geology, and chemistry fields are generally balanced labor markets.
National Science Foundation, Division of Science Resources Studies	Trends in Science and Engineering Degrees, 1950 Through 1980 7 Oct. 1981	1950-1980	Science and Engineering Graduates	Summary Report	The numbers of S&E degrees awarded annually is now below the levels reached in the early to mid-70s. S&E fields, which accounted for about 60% of all doctorates until 1969, now account for only 50%. Demographic factors cause some observers to believe that the leveling off in the production of S&E graduates since 1974 is but a prelude to further declines expected to begin in the mid-80s. The report provides a summary and analysis of the salient features of post-World War II S&E degree production.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
National Science Foundation	Federal Scientific and Technical Personnel 1976, 1977, 1978 NSF 80-309	1976-1978	Scientists and Engineers working for the federal government excluding uniformed military personnel and federally employed S&Es who work in non-science/non-engineering areas.	Detailed Statistical Tables	The federal government employs about 8% of all working scientists and engineers in the U S Tables provide detailed characteristic data on this group
National Science Foundation	Foreign Participation in U.S. Science and Engineering Higher Education and Labor Markets NSF 81-315	1970-1980	Foreign recipients of U S S&E degrees	Special Report	Foreign participation in higher education in the U S became increasingly pronounced during the 1970s, especially at the graduate school level. The growth has been more pronounced among science and engineering disciplines. Four of every ten engineering graduate students are foreign, as are almost five of every ten engineering doctorate recipients. The short-term impact of foreign citizens on the domestic S&E doctorate labor supply is trivial -- less than 1%. The long-term impact could be significant if trends continue. Report includes statistical data concerning these trends.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
Hearings before the Committee on Science and Technology, U.S. House of Representatives	Engineering Manpower Concerns 6 Oct. 1981	1980-1990	Scientists and Engineers	Testimony, Hearings	Mr John W. Geils, on loan from AT&T Co., is Staff Executive of the American Society for Engineering. He is leading a two-year project funded by eight major U.S. corporations to take positive actions to solve the engineering college faculty shortage problem. Exxon announced a $15M grant to 66 schools to provide living expenses to graduate students and salary supplements to faculty. It has been estimated that it will take $250M per year to fix and maintain the colleges' laboratory equipment problems. He makes six specific recommendations for a problem to alleviate the problem. Gen. Robert T Marsh, Air Force Systems Command, testified that high school graduates are ill-equipped to pursue engineering courses at the college level. There has been a 15-year decline in SAT scores in mathematical and verbal skills, and in science and mathematics achievement test scores. Only a small percentage of secondary school graduates have taken courses in science subjects New equipment needed by an engineering college would cost $100,000 per year per program, plus $150 per student per year. Most engineering colleges do not have access to such capital. The Air Force is substantially dependent upon S&E personnel of which there is currently a shortage -- both experienced and entry level. Dr. Robert A. Frosch testified by citing results of numerous studies and reports on S&E shortages, their causes and trends.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
American Defense Preparedness Association	Engineering/Scientific Personnel for the 1980s and Beyond Sept 1981	1980-2000	Scientists and Engineers	Report on a conference	During the coming decades, the U.S is likely to be confronted with increasing competition both from already industrialized countries and from those newly emerging industrialized countries with enormous labor resources. The U S. cannot compete successfully in this environment unless it strengthens its technological base This, in turn will require that the nation have sufficient numbers of engineers, scientists, and technicians. Views are presented from academia, industry, and the military Conclusions and recommendations from conference workshops are summarized.
Task Force Members of the American Association of Engineering Societies	Data Related to the Crisis in Engineering Education March 1981	1970-1980	Engineers	Selected Data	The shortage of qualified faculty for engineering colleges is serious In many cases, engineering laboratory facilities are one or more generations out of date. Current needs for engineering college faculty members outstrip the total new Ph.D. production and new Ph.D s are highly sought after by industry and government. Supporting data are presented.
IEEE Spectrum June 1981	A Crisis in Electrical Engineering Manpower by Stephen Kahne June 1981	1970s	Electrical Engineers	Article	Academic salaries have not kept pace with inflation over the past decade. Laboratory teaching facilities are largely based on technology of the early 1960s. There is a slow, but definite trend of established engineering faculty members leaving universities for industry. Student-faculty ratios in engineering schools now average 20 1, with some major schools as high as 50 1. Data are supplied to support the conclusions.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
American Electronics Association	Plan for Action to Reduce Engineering Shortage With Supporting Data by P. H. Hubbard Oct. 1981	1975-1985	Electrical Engineers	Committee Report	The shortfall of engineers for the electronics industries projects to 25,000 EE/CS baccalaureate engineers annually through 1985. Shortage is primarily due to a lack of engineering faculty. Laboratory equipment, now 20 to 30 years old, is outdated and in short supply. Faculty vacancies are nearly 50% in solid-state electronics, computer engineering, and digital systems. Estimated total demand for new BS/EE and CS people is about 199,000 by 1985. Estimated total supply is about 70,000. Just to meet the needs of electronics, education must triple its output of EE and CS engineers each year for the next five years. Data on comparative salaries and other factors are presented
IEEE Spectrum Nov. 1981	Engineering Education. Coping With the Crisis by T.S Perry Nov. 1981	1980 and Beyond	Engineers	Article on Panel Discussion	Solutions to the crisis in engineering education are discussed by prominent panel members. Increase engineering faculty salaries, both absolutely and in relation to medicine/law. The American Electronics Association will try to increase the use of visiting professors from industry. Grants of $12,000-$15,000 per year to support top Ph.D. candidates were suggested. Panelists agreed that government, industry, and academia must share the responsibility for solving the problem. The American Electronics Association is asking its 1,700 member companies to contribute the equivalent of 2% of their R&D budgets, or an equivalent of $30M to $50M annually to help with faculty salaries and increased capacity.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
The Washington Post	Schools Shrink, Need for Engineers Grows, by Robert J Samuelson	1975-1985	Engineers	Article	Since 1975, engineering enrollments have risen by about half One university experienced a jump from 7% to more than 20% of graduates majoring in engineering during that time Laboratories and classrooms are packed. In 1979, a poll found that 70% of respondents felt science and technology produce more good than harm, up from 54% in 1972 but down from 88% in 1957 The American Electronics Association surveyed 671 firms with 1980 sales of $80 billion to find that by 1985 these firms project a need for some 50,000 new electrical and computer science engineers compared with 15,000 expected graduates. Universities that have absorbed higher enrollments by increasing class size may now be reaching limits. Only about one fifth of America's college graduates major in science (between 5% and 6% in engineering).
National Science Foundation, Directorate for Science Education	Science Education Databook SE-80-3 Undated	1960-1979	Science Educators in the U.S	Databook	Data on students, teachers, classes, subjects, test scores, degrees, sex of that population, and work activities of trained scientists and engineers.
National Academy of Engineering	Issues in Engineering Education April 1980	1980s	Engineers	Summary of Task Force Findings	Survey of engineering professionals in academia, industry, and government. Identified a set of general programmatic recommendations for stimulating the flow of engineering graduates through universities
National Academy of Engineering	Educational Technology in Engineering, 1981	1950-1980	All Students	Report	Educational technology (ET) encompasses not only the use of materials and hardware to aid in the learning process, but also the systematic organization and presentation of knowledge to the learner The report focuses on effective examples of ET as it is practiced in Engineering Education. It calls for new programs which would capitalize on the decentralization of the new, inexpensive, stand-alone ET delivery systems.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
Control Systems Magazine, IEEE	Progress, Productivity, and People A Perspective by Lester A. Gerhardt Sept. 1981	1979-1986	Engineers	Article	Undergraduate enrollments in engineering schools are increasing. The freshman engineering class was 52,000 in 1973 and almost doubled to 103,000 in 1979, reaching 110,000 in the fall of 1980, but demand still exceeds supply. The demand for computer programmers is predicted to double with 250,000 new positions by 1990, but colleges are turning out only one-third as many Bachelor Degree graduates as employers want, at least to 1986. Suggestions are made for actions to be taken by industry, academia, and the government to ameliorate this situation
National Science Foundation	National Patterns of Science and Technology Resources, 1980 NSF-8-308 Mar. 1980	1965-1978	Scientists and Engineers	Summary Report	Presents a summary of U.S. science and technology resources. Presents a complete set of time-series tables, including scientists and engineers in terms of employment status, baccalaureates employed in occupation coincident with their field of degree, employment growth, and degree production.
Oak Ridge Associated Universities	Science and Engineering Technicians in the United States, Characteristics of a Redefined Population, 1972 Feb. 1978	1972	Science and Engineering Technicians	Report	Approximately 75% of the technicians distributed among 10 work fields were concentrated in four relatively large fields: computer programmers, electrical and electronic technicians, draftsmen, and others. The average age of technicians in 1972 was 37. About one-third of all technicians had no postsecondary education, about one-sixth had at least a bachelor's degree. In 1972, unemployed technicians totaled 3.2% of the technician labor force. Private companies employed 71% of the technicians, federal and state governments employed 12.4% and 7.4%, respectively. Greater attention must be directed to the coordination between technician occupations and specific educational programs.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
National Science Foundation	Research and Development in Industry, 1978 NSF-80-307	1978	Scientists and Engineers	Detailed Statistical Tables	R&D scientists and engineers by industry and size of company
National Science Foundation	National R&D Spending Expected to Reach $67 Billion in 1981 NSF-80-310 23 May 1980	1968-1981	R&D Scientists and Engineers	Summary Report	Total research spending in the U S is expected to reach a current-dollar level of about $24 billion in 1981, an increase of 10% over the expected 1980 figure The federal government, which supports 70% of the nation's basic research, accounted for nearly 80% of the increase There were 602,000 R&D scientists and engineers engaged in R&D activities in 1978, 5% more than in 1977 It is expected that the employment of R&D scientists and engineers will continue to increase to about 660,000 in 1980
National Science Foundation	Doctoral Institution's Report 6% Real Increase in R&D Expenditures in FY 1978 NSF-80-301 3 March 1980	1974-1978	Academic R&D Expenditures	Summary Report	Both federal and non-federal sources have been responsible for four consecutive years of real growth in academic R&D funding, producing an 11% increase in real terms since 1974 R&D expenditures by doctorate degree granting universities account for 98% of all organized research in academia R&D spending increased for all major S&E disciplines, with the largest relative increase occurring in engineering, up 19%.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
National Science Foundation	Research and Development in Industry 1975 NSF-77-324 Jan. 1976	1965-1975	R&D Scientists and Engineers in Industry	Survey Report and Detailed Statistical Tables	In constant dollars, industrial R&D expenditures declined by 4% between 1974 and 1975. Over the decade 1965-75, industrial R&D spending rose 66% in current dollars, when inflation is removed from the figures, the 1975 level is 3% less than that of 1965 The number of scientists and engineers employed in industry increased by 800 between January 1975 and January 1976 to a level of $61,600 This continues the gradual rise in professional R&D employment which began in 1973, but the 1975 level is well below (6%) the peak employment year of 1969. The entire decrease is attributable to diminished federal support of industrial research and development, between January 1969 and January 1975, the number of R&D scientists and engineers engaged in federally-supported R&D projects fell from 157,700 to 108,800.
National Science Foundation	New Directions in Continuing Education Changing Roles of Universities, Industry and Government SED-78-22139 March 1980	1980	All R&D Personnel	Report	Continuing education is universally recognized as essential to prevent technical obsolescence among scientists and engineers High starting salaries in industry for engineers with bachelors' degrees create lack of incentives to stay in school for higher degrees. Education and training in science and engineering is becoming less and less confined to degree programs. Important research takes place increasingly within industry, and universities experience difficulty in recruiting and keeping talented scientists and engineers.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
Office of Deputy Under Secretary of Defense for Research and Engineering (Research and Advanced Technology)	The DOD Science and Engineering Apprenticeship Program for High School Students A Report on the Summer 1980 Program	1980	High School Students	Report	The program consists of practicing scientists identifying high school students and working with them during the summers and other school vacations to give them an understanding of the scientific method and foster their desire to pursue college level training that would lead to careers in science and engineering The DOD total of apprentices as of the fall of 1980 was 299 Mentor evaluations of the students were enthusiastic Comments from apprentices indicate that they benefited from the learning experience Princeton University wants to copy the program.
National Science Foundation	Employment Patterns of Academic Scientists and Engineers, 1973-1978 NSF-80-314	1973-1978	Scientists and Engineers	Special Report	Research is playing a greater role in most academic institutions in the selection of new S&E staff. By 1978, research comprised almost one-fifth of total education and general income at universities. Women accounted for almost one-third of the net 1974-78 growth in employment of full-time academic scientists and engineers
National Science Foundation	Science and Engineering Personnel A National Overview NSF-80-316 June 1980	1976-1978	Scientists and Engineers	Report	Employment in S&E jobs increased for engineers, but fell for scientists between 1976 and 1978 Except for computer specialists, who had a growth rate of over 30%, and environmental scientists up 20%, employment fell in all major fields of science. Mobility between S&E and non-S&E jobs can alleviate labor market imbalances. Of the almost 175,000 persons in technical and related occupations (but not science and engineering) in 1972, more than 62,000 (36%) had entered S&E jobs by 1976. This return flow has been in response to the relatively strong employment opportunities for engineers

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National Science Foundation	Academic Employment of Scientists and Engineers Increased 4% in Doctorate Institutions in 1979 NSF-80-309 30 Apr 1980	1979	Scientists and Engineers	Summary Report	The number of professional scientific and engineering personnel employed at doctorate-granting institutions increased 4% between January 1978 and January 1979, matching the 4% per year average growth rate of the previous four years. The growth in S&E employment experienced since 1974 is expected to slow during the early 1980's as a result of an anticipated leveling off or decline in enrollment due to demographic factors.
National Science Foundation	U.S. Scientists and Engineers, 1978 NSF-80-304	1974, 1976, 1978	Scientists and Engineers	Detailed Statistical Tables	Time series tables of statistical data, in terms of occupation, sex, age, degree, type of employer, work activity, and race.
Evaluation and Training Institute	The Study of Women in Science and Engineering 1979	1965-1975	Women in Science and Engineering	Summary Report	The number of women receiving doctorates in science and engineering rose from about 750 in 1965 (7%) to nearly 3,000 (17%) in 1976. Women scientists/engineers employed full-time in academia are concentrated in the very largest institutions.

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National Research Council, National Academy of Sciences	Letter from William Kelly to Richard DeLauer dated 16 June 1981 with background paper	Present	Practicing Scientists and Engineers	Background Paper	In the past decade, interaction scientists and engineers from the U S and other developed countries has declined At the same time, increasingly larger numbers of developing country researchers are enrolling in developed country institutions Scientific and technological competence is becoming dispersed More than half the R&D now takes place in industrialized nations other than the U S The Committee on International Human Resource Issues will examine the trends of international mobility and report on how these trends work for good or ill in maintaining the health of U.S. science and technology
National Academy of Sciences	The Ph D Employment Cycle - Damping the Swings by Harrison Shull April 1978	1970's	Engineer Ph D s	Summary Paper	Shortages and excesses in the supply and demand for scientists and engineers are not infrequent in the United States Oscillations are particularly apparent in the job market for engineers There are some important differences between training engineers and training research scientists and physicians. The demand by the market for newly minted engineers is strongly influenced by the state of the economy The link between supply and demand is approximately five years long Two remedies are needed (1) Stability in total support funds available to agencies supporting basic research, particularly the National Science Foundation, and (2) The ability of these agencies to shift funds quickly between pre- and post-doctoral support in response to a fluctuating job market.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
National Research Council/Commission on Human Resources	The Effect of Military Personnel Requirements on the Future Supply of Scientists and Engineers in the United States October 81	1980-2000	Scientists and Engineers	Papers and Conference Report	Concern exists for the potential effects of military personnel requirements on the supply of scientists and engineers Conclusions of the study are (1) Reinstatement of conscription would likely have a substantially smaller effect on the future supply of scientists and engineers than might first appear to be the case, (2) The actual effects of military manpower procurement policy on the future supply of scientists and engineers depend not only on such obvious factors as force sizes and whether a draft is used, but also importantly on seemingly second-order factors as military pay levels, quality standards, draft deferments and exemptions, and conscientious objectors, (3) Policy changes depend critically on how such changes alter individual behavioral patterns, such as college participation rates, and (4) Even if military manpower policy does not change, demographic trends alone will result in 20% lower S&E graduates by the end of the decade.

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National Research Council/National Academy of Sciences	The Demand for New Faculty in Science and Engineering 1979	1976-2000	Science and Engineering Faculty	Proceedings of a Workshop	A committee was charged with evaluating existing projections of the demand for young faculty in the various fields of sciences and engineering, with assessing the potential damage (if any) to the research enterprises that might result from declines in the representation of young persons on science and engineering faculties, and with recommending appropriate policies to counteract such damaging effects Projection models are evaluated and discussed
National Research Council	Graduate Merit Fellowship Program, Memo from W C Kelly 3 Sept 81	Present	Postgraduate Scientists and Engineers	Draft Description of a Program	Some 31,000 persons have received NSF graduate fellowships since 1952 Currently, about 3,500 undergraduate seniors in the physical and biological sciences, mathematics, engineering, medical sciences, and social sciences apply each year for about 450 fellowships Awards are for 36 months The 12-month stipend is $6,900 and the host institution receives $4,000 annually as a cost-of-education allowance for each Fellow The above program is inadequate Suggestions are made for a Graduate Merit Fellowship Program The program would require cooperation between the federal government and the private sector The cost would be shared between federal tax dollars and private funds.

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Association of American Universities	Defense Requirements and University Preparedness October 81	1960-1980	Scientists and Engineers	Report of the AAV Task Force	There are obvious and growing deficiencies in the university research base that pose particular concerns to universities, industry, and the DOD Universities face serious and growing problems, particularly in their faculties, research facilities and instrumentation, and in graduate enrollments in certain critical science and engineering disciplines Recommendations are. Provide sustained real growth for DOD university research programs at a rate of 10% per year for the next 4 years, establish a new graduate fellowship program in S&E which, in each of the next four years will award 500 fellowships at a yearly stipend of $15,000 plus tuition, establish special ROTC programs in science and engineering establish within the OASD (R&T) a New Research Equipment and Facilities Renewal Program, budgeted at a level equal to 25% of the DOD research budget

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SRI International	Education and Employment of Scientists and Engineers in the U S and the USSR Summary Report and Commentary on Implications for U S National Security Policy SSC-TN-ISR-15 May 1981	1980-2000	Scientists and Engineers	Summary Report	By conscientious effort over the years, the Soviet Union has increased its efforts in the training of scientific and engineering personnel to the point that its programs now dwarf those in the United States Because this effort has proceeded silently, it has gone largely unnoticed in the U S If the U S fails to respond, however, there can be little doubt that eventually it will find itself technologically inferior to the Soviet Union Key findings are Although U S elementary school students receive slightly more hours of science per week, Soviet schools devote considerably more time to mathematics, the Soviet Union has developed specialized secondary schools providing applied technical training There is no broad scale equivalent training in the U S , in engineering fields, the Soviet Union graduated 6 times the number of specialists at the undergraduate level as did the U S , about 70 percent of Soviet graduate enrollment is in the sciences and engineering fields while the U S percentage has steadily declined since 1960 to only 20 percent in 1976, in 1974, the USSR had over twice as many natural scientists and engineers as the U S

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American Society For Engineering Education	The Crisis in Engineering Education March 81	1930-1985	Engineering Faculty	Summary Report with Backup Data	Severe overcrowding of generally antiquated facilities by 360,000 engineering undergraduates has created a demand for engineering professors which cannot be met by the universities Approximately 1,600-2,000 positions remain unfilled Only 2,700 engineering Ph.D s were granted in 1980 1,000 less than in 1973 Roughly 1,000 of these are foreign nationals Faculty salaries are very much below those in industry Laboratory equipment is extremely out of date and will require an estimated $800 million to restore to a condition approaching the state-of-the-art. Unless corrective action is taken quickly, there is serious doubt about the ability of the engineering colleges to satisfy the future industrial and defense engineering manpower needs of the nation

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American Society for Engineering Education	Statement of W Edward Lear before the Subcommittee on Energy and Water Development of the House Committee on Appropriations 25 March 81	1980	Scientists and Engineers	Statement	Undergraduate engineering enrollment in the U S is at an all-time high resulting in excessive faculty loads and overcrowded facilities In 1980, 59,000 B S degrees were awarded, compared to 38,000 four years earlier This represents only 6% of all bachelors degrees awarded in the U S compared to 21%, 37%, and 42% for Japan, West Germany and Eastern Europe, respectively Starting salaries are in the $25,000/year range in industry for some disciplines The fresh graduate frequently commands a higher salary than some of his Ph D - trained professors Engineering Ph D production in the U S was 2,700 in 1980, down 1,000 from the 1972 figure Roughly 1,000 of the 2,700 are foreign nationals Among the remaining U S citizens, 63% typically take jobs in industry or government, leaving 600-700 available for faculty jobs. There are 2,000 open faculty positions in the U.S. engineering colleges today An estimate is made that it will require the production of 1,000 new engineering Ph D s per year to eliminate the shortfall of faculty over the next several years. The private sector is beginning to take up some of the load The Engineering Manpower Task Force of the Business-Higher Education Forum is a group of 30 major corporate chief executives and an equal number of university presidents organized by the American Council on Education.

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American Defense Preparedness Association Conference	Engineering-Scientific Personnel for the 1980's and beyond by Edmund T Cranch December 80	1980-1990	Scientists and Engineers	Speech	Makes the following recommendations Increase the number of graduate fellowships in order to enhance the pool of potential faculty members, industry should grant the university 30% of the starting salary for each Ph D it hires, encourage the use of adjunct professors from industry, create a partnership between industry and universities to co-hire young faculty, implement a national program of laboratory equipment aimed at the undergraduate level of engineering, establish new or modified ROTC Programs directly coupled to colleges of engineering
American Society for Engineering Education/ Engineering Education News, June 1981 Vol 7 No 12	Companies Provide Funds for 2-year Post, Staff Executive to Tackle Shortages	1980	Engineering Faculty	News Article	AT&T, DuPont, Exxon, GE, GM, GTE, IBM and Union Carbide have agreed to provide $100,000 annually for two years for a new position of Staff Executive who will Bring together relevant data on faculty shortages, develop, with industry, a plan of action to solve the faculty problem, work with industry, government, and universities to implement the plan, and coordinate the activities of other industrial and associations' reports

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National Academy of Engineering	Issues in Engineering Education A Framework for Analysis April 80	1980	Scientists and Engineers	Report on Task Force Meetings	A Task Force on Engineering Education held two formal meetings in 1979-80 General recommendations were made for immediate action and for long-term actions Recommendations were in the form of creating panels, committees, and councils to monitor, advise, and recommend actions
The Bridge, Vol 11 No 1, Spring 1981, National Academy of Engineering	The Growing National Crisis in Engineering Education by Courtland D. Perkins	1980	Scientists and Engineers	Article	Since World War II, the connection between graduate engineering research and high technology industry has been slowly dissipating The exponential rise in sponsored research in graduate engineering schools is about 95 percent government funded, in many cases it is of little interest to industry In many cases, engineering doctorates have little interest in U S industry, nor industry in the available Ph D s There are too few engineering school faculty members with substantial industrial experience As a result, industry is developing their own programs They bring in the best graduating seniors, pay them well, involve them in industry programs and keep them

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The Bridge, Vol 11, No 1, Spring 1981 National Academy of Engineering	Scientists, Engineers, and National Security An Educational Perspective by Arthur G. Hansen	1980	Scientists and Engineers	Article	Three pressing problems are described One is the armed forces need for technically trained personnel and the difficulty of hiring and training such personnel The second is the training of scientists and engineers and making certain that the demand of the military will be met in the years ahead. Third is the need for scientists and engineers in building a strong economy. In the long run, failure to meet our economic needs may be a more serious threat to national security than some of our short-term manpower requirements in certain parts of our defense system
USAF Scientific Advisory Board, Ad Hoc Committee	Special Report on Scientific and Engineering Manpower Shortfalls within the Air Force October 1979	1980's	USAF Scientists and Engineering Personnel	Special Report	Nationally, the number of S&E graduates is at best fixed and will more likely decline. Within an atmosphere of increasing need and dwindling supply, the Air Force at this time, cannot compete monetarily in the market place for new engineers or hire experienced military S&E personnel at any level but the entry level The alternative is to sponsor its own new engineers, and keep them in touch, through subsidized post-graduate programs, with the latest developments in technology throughout their careers. Data are presented to support this alternative Short-term and long-term actions are identified to address the anticipated shortfall of S&E personnel in the Air Force

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Subcommittee on Economic Goals and Intergovernmental Policy of the Joint Economic Committee, U S Congress	Statement by W Paul Cooper 3 November 1981	1980's	Machine Tool Technicians	Testimony	The recession of 1970-71 was a depression for the machine tool industry which lost 25% of its work force It is estimated that the U S would be short 250,000 skilled machinists by 1985 Projections from 1979 emphasize the need for 23,000 skilled machinists each year for the next ten years It takes 3 or 4 years to train skilled technicians Most of the training must be conducted by employers This investment is typically in the range of $25,000 to $40,000 for a 4-year apprenticeship program About 15,000 people have been trained through on-the-job training in Department of Labor programs at an average cost to the taxpayer of less than $1,000 per trainee
Accreditation Board for Engineering and Technology/National Academy of Engineering	Engineering Education - Aims and Goals For the Eighties July 26-31 1981	1980's	Engineers	Report	The ratio of students to faculty members in engineering schools has increased to a dangerous level If quality education is to be maintained, we must either limit enrollments, or increase faculty size or increase graduate teaching assistants, or some combination of the above Insufficient numbers of B S graduates who are U S citizens are entering engineering graduate schools We must make graduate study more attractive by increasing stipends to one-half of the entry level salaries for B S graduates entering industry Immediate measures are needed to increase current stipends of $7,000 annually to $11,500 As soon as possible, starting salaries for assistant professors should be increased to a level equal to one-third more than the entry-level salaries for B S graduates entering industry

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American Association of Engineering Societies	Letter from Bruno Weinschel to Dr. Wm Blanpied NSF 23 October 81	1980's	Scientists and Engineers	Summary Overview	Comments on an NSF report that concludes Science manpower for the 1980's and beyond is in relatively good shape in terms of quality and quantity, we are creating a generation which is technologically illiterate because of reduced requirements in high school curriculum, there is presently a serious shortage of engineers which is expected to disappear about 1990 except in the area of computer science Comments that The production mechanism for engineers in our 276 engineering schools is deteriorating because of both a shortage of faculty and the use of lesser qualified faculty There are about 2,000 unfilled positions for engineering faculty among 15,000 to 20,000 The average age of the capital equipment used in laboratories for teaching is about 17 years U S engineering is not performing well in support of national goals The U S imports 25% of its automobiles, 25% of its steel, and almost all of its entertainment electronics Passenger aircraft, computers, and microcircuits are losing ground to foreign competitors The exceptional performance of the U S in science research, as evidenced by the quantity of Nobel prizes awarded in the sciences, has not helped the U S to remain competitive The Japanese are producing engineers at the B S level at a 2 4 times per capita rate relative to the U S. They are adapting our research findings to commercial products. In order not to burden our economy with the cost of continual renewal of laboratory equipment in the universities, there must be an increase of students taking summer employment in industry. We fail in the U S. to have one place within the government or outside the government a focal point for complete interchange of information on skilled technical manpower needs. We need strategic planning at one focal point regarding those needs

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American Association of Engineering Societies	Letter to R D DeLauer from Bruno Weinschel 3 September 81	1980's	Engineers	Reports Enclosed	One enclosed report suggests that members of the engineering profession contribute to the solution of the problem of a shortage of engineers by becoming active in the teaching, sponsorship, and stimulation of engineering education Recommendations are made for faculty, industry, and government
American Association of Engineering Societies	How to Prepare Engineers to Improve U S Competitiveness in the 1980's By Bruno Weinschel IEEE 1980	1980's	Engineers	Paper	Discussion and data are presented to support the following conclusions U S engineering education must produce graduates who have learned to design for cost, reliability, and quality, U S engineering schools must have close ties to industry, graduates must realize that the economic recovery of the U S requires design of products for a world market and not just a domestic market Over the last 30 years, the support of engineering research in U S engineering universities has been taken over more and more by the government, especially the mission agencies and the NSF Engineering universities have become progressively divorced from industrial ties Engineering for defense and space is goal oriented, not cost oriented This attitude, learned by many of our research students supported by government research funds, is useless when attempting to design for cost and be competitive In the U S we fail to have government-supported research institutes equivalent to those in Germany which perform R&D in the civilian area even if the government is not the major customer. Examples are The Iron and Steel Institute in Duesseldorf, The Silicate Institute in Dahlem, The Wood Research Institute in Elberswald, The Diesel Engine Laboratory in Dresden. These institutes are financed usually by less than 50% of government funds and are staffed frequently by universities

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Weinschel Engineering Co., Inc. AAAS Colloquium on R&D and Public Policy	R&D and the New National Agenda by Bruno Weinschel 26 June 81	1980's	Engineers	Paper	There is a need for consensus-type strategic planning in the area of both technical manpower and technology policy. The latter is performed successfully by our largest industrial corporations and the DOD. However, there is no such focal point for the civilian economy. During the past 20 years, engineering schools became accustomed to increased financial support from federal agencies instead of industry, because industry support was discontinuous. Industry must learn to support engineering schools on a continuous basis in order to maintain the facilities supplying its future engineers. There is a need to expand and reorient engineering education. Many engineering schools neglect education in materials, fabrication methods, and manufacturing technologies. Their graduates are often oriented toward research and are ignorant of how to design a manufacturable product which will satisfy the needs of the user, can be cost competitive, and reliable. U.S. industrial management and boards of directors come from professions other than engineering or scientists. They are lawyers, marketeers, accountants, and financiers. In West Germany, the senior managers of industry emerge through the engineering ranks and about 60 percent of the members of their boards of directors have an engineering background. In 1979, in the U.S., we graduated about 34,000 lawyers while graduating only about 17,000 engineers with a master's or doctor's degree. U.S. management is failing to keep their companies technologically competitive.

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National Science Foundation	Projections of Science and Engineering Doctorate Supply and Utilization 1982 and 1987 NSF 79-303 April 1979	1982-1987	Scientists and Engineers	Summary Data	About 17 percent of all S&E Doctorates in the 1987 full-time labor force may not be employed in S&E positions. Data are displayed concerning the utilization of doctoral graduates in various S&E fields
National Science Foundation	U S Scientists and Engineers 1976 NSF-79-305 1976	1976	Scientists and Engineers	Detailed Statistical Tables	Data are provided on scientists and engineers in terms of labor force, occupation, employment status, and sex
National Science Foundation	Summary Statistics on Academic Science/Engineering Resources Nov 81	1980	Scientists and Engineers	Summary Statistics	Statistics include national R&D expenditures by sector, personnel employment, federal support of colleges and universities, and graduate students

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OUSD/R&D	Notes on the Meeting of the National Engineering Action Conference, 29 Oct 81 by Ms Jeanne Carney	1980's	Engineers	Notes on Conference	There is a growing awareness that engineering education in this country is getting into serious trouble in that There is a shortage of doctoral graduates in engineering, there is an engineering faculty shortage, the problem is not transient and will get much worse unless the situation is reversed immediately, the condition exists in most fields of engineering and in computer science The subject has been addressed at meetings and by reports but there has been little action A small number (100) of additional graduate fellowships were started in the fall of 1981 under industrial grants Testimony had been given before congress There is some evidence that some schools are taking more aggressive action to recruit for graduate school and make faculty salaries in engineering a little more competitive with industry

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National Engineering Action Conference	Draft Declaration of Intent for the National Engineering Action Conference by Robert Stambaugh	1980's	Engineering Education	Declaration of Intent	Purpose of NEAC to raise awareness and encourage cooperative action among decision-makers in academia, industry, government, and professional educational and technical societies, raise awareness and support for the engineering education crisis with the general public, send strong signals to potential graduate students that the nation's leaders are behind them, reassure the engineering faculty that their vital role will be supported The declaration of intent lists the following objectives To fill the nearly 2,000 engineering college faculty vacancies which now exist, to increase the number of doctoral candidates in engineering, to increase the percentage of American-born doctoral candidates, to ensure the quality of undergraduate engineering education through stronger faculties, to upgrade unsatisfactory physical facilities, to provide modern laboratory equipment

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National Academy of Engineering. Letter from Albert Murray to Dr Russell McGregor dated 30 Oct 81	Summary of NAE Roundtable on Encouraging Graduate Engineering Education Draft 28 Oct 81	1980's	Engineering Education	Summary Report	Conclusions were there is a clear shortage of engineering faculty, but no evidence of a Ph D shortage in industry, more Ph D candidates will not necessarily help the faculty problem, faculty jobs need to be more attractive, industry can help augment faculty income and can provide stimulating contacts incentives that may induce faculty to embrace industry contacts may also lead to considering changes in the structure of engineering education The council on Chemical Research, a newly-formed coalition of about 40 companies and 100 schools is trying to devise both one-to-one and centralized funding mechanisms They find an overwhelming preference for one-to-one giving Example programs were Direct support of graduate students with attractive stipends and requiring periods of work at the sponsoring firm - Hughes Aircraft Co , Lehigh University, Fairchild Space and Electronics, making modern equipment available to educate students - George Washington University/Langley Research Center, Amoco/Northwestern University for $6M laboratory, Exxon/MIT funding combustion program, Exxon/Northwestern University cooperative program, Alcoa consulting budget of $1 5M Questions were raised about the Ph D degree as a prerequisite for teaching engineering This is a barrier to obtaining adjunct faculty There is the question of whether a Ph D is appropriate or relevant to engineering As schools emphasized the Ph D , pure engineering science was emphasized in research and teaching As a result, the basis for a close partnership between academia and industry decayed. As long as universities persist in the requirement while industry remains indifferent to it graduate engineering education faces the risk of being irrelevant to industry There are clear signs that industrial growth and technological progress could support a strongly growing market for new B S and M S. level graduates

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ASEE Annual Conference on Engineering Academic Disaster, 22 June 81	Fundamental Engineering Education Needs and Issues for the 1980's and Beyond by Edmund T Cranch President, Worcester Polytechnic Institute	1980-2000	Engineering Education	Paper	Required actions are increase the number and attractiveness of graduate fellowships, establish incentives and mechanism for adjunct professors from industry, create a partnership between industry and universities to co-hire young faculty, introduce tax incentives for industry to apply to supplied laboratory equipment, implement a national program of laboratory equipment for undergraduate engineering education, provide government support to strengthen engineering education, identify and support undergraduates who want careers in engineering education
Armed Forces Journal International January 1982	AFSC Scientist and Engineer Shortfall of Grave Concern, Outlook Bleak by Deborah Kyle	1980's	Scientists and Engineers	Article	The Soviet Union outdistances the U S on available technical expertise Roughly 900,000 scientists and engineers are presently engaged in R&D work within the Soviet Union, one third more than are employed in the U S In 1980, the Soviets graduated 300,000 engineers, the U S only 58,000 The Air Force Systems Command currently employs 53,000 people of whom 23% are scientists or engineers In 1978, AFSC had 83% of its S&Es classified as experienced, but in 1980 that level dropped to 66% Industry, in a desperate need for qualified S&E personnel, is hiring away mid-level military trained personnel Industry offers median salaries in the low $20K range compared to about $16K in the Air Force To date, little more than identifying the problems and highlighting the needs have been done by academia, industry and the government It will take a national commitment and program reminiscent of the space program in the early 1960's to motivate America's youth to seek technical professions

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Congressional Research Service, Library of Congress	United States Supply and Demand of Scientists and Engineers Effects on Defense Research and Technology Part 1, Current Situation and Future Outlook by Edith F Cooper 6 November 1981	1980's	Scientists and Engineers	Report	Supply and demand data on S&E personnel are compiled and assessed for the U S USSR, China, France, West Germany, Great Britain, Japan In 1976 the U S had the largest number of graduates in all fields of academic study, followed by the Soviet Union, Japan, West Germany, and France The Soviet Union, however, had the largest number of graduates in science and engineering, with the U S second In 1979, the Soviet Union continued to graduate more than twice the number in science and engineering than did the U S., and almost 5 times as many engineering students In the physical, life science and mathematics areas the U.S continued to award almost twice as many degrees as did the Soviet Union, but lagged behind in agricultural sciences By 1990, the supply of scientists and engineers should be adequate to meet the demand in all fields except the computer professions, statistics, and industrial engineering There is a possibility of shortages in some areas of aeronautical engineering These projections are based on the assumption that colleges and universities will have the capacity to educate all qualified undergraduate students who will be seeking S&E degrees.

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Congressional Research Service, Library of Congress	Engineering Manpower A Survey of the National Problem and the Problem in the Department of Defense by Paul Zinmeister 21 December 1981	1980's	Engineering Manpower	Summary Report	Report summarizes other reports and congressional testimony In general, the supply/demand problem for the decade of the 1980's has not yet been fully sorted out The tendency has been to describe the supply/demand problem in universal terms when it appears that there are shortages in some engineering fields and not in others The NSF and Department of Education have estimated that there will be a gradual decline in the engineering manpower shortage until 1990, at which time the supply/demand will for the most part be in balance Sponsorship programs in industry are described DOD S&E manpower problems are described

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The National Engineering Action Conference, Business - Higher Education Forum, Phoenix, Arizona	Engineering Manpower Issues by Dr Edward E David, Jr 16 January 82	1980's	Engineering Manpower	Speech	An immediate concern is the retention of engineering faculty and the critical shortage of engineers pursuing doctoral degrees and entering the teaching profession A consensus view is that this engineering teacher shortage will persist and likely worsen, unless immediate action is taken Twenty of 30 universities surveyed had decided to limit enrollments due to faculty shortages The differential between starting salaries in industry and the current average salaries paid to faculty has increased from 22 to 33 percent in the past 4 years The median age of university instrumentation is twice that of the instrumentation in two large industrial laboratories (35 years versus 7 years) Estimates of $150 to $200 million annually is required to attract new faculty, retain existing teachers, and provide financial support for more graduate students Suggestions are made for industry, academia, and the government A quote from the President's Science Advisor, "Although this situation has serious national implications, it is primarily one of a marketplace working as it should, and does not require a massive response This is a problem that must, and can be, worked out by those who supply scientific and engineering manpower and those who utilize it "

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American Association for the Advancement of Science	Engineering Manpower Needs of Industry by Robert P Stambaugh 8 January 82	1980's	Engineering Manpower	Speech	Engineering manpower needs are unpredictable Estimates of such needs for the synfuel program have ranged from no significant additional engineering personnel to an additional need for 30,000 engineers A model is described that shows that an essential balance exists between supply and demand in the total population of practicing engineers It is a result of the largely unrecognized elasticity in both supply and demand Consequently, no massive initiatives on a national scale are needed to increase the production capacity of our schools of engineering As for Ph Ds in engineering, neither the supply nor the demand is elastic and currently there is a large deficit in supply over demand Consequently, the Ph D shortage requires the urgent attention of leaders in universities, industry and government

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Committee on Sciences and Technology, U S House of Representatives	Reagan Administration's Science Policy, by Dr George A Keyworth	1980's	Science Policy	Statement	Today's federal role in science and technology must be different from that which prevailed since World War II The U S spends more money on R&D than any other country in the free world The ratio of R&D expenditures to GNP in the U S compares favorably to that of other major industrialized countries The trade surplus which the U S has enjoyed in R&D-intensive products has grown from $6 7 billion in 1962 to $39 3 billion in 1979 There are a number of good reasons why we cannot expect to be preeminent in all scientific fields, nor is it necessarily desirable Arguments for a government role in civilian R&D apply most strongly to basic research The universities are finding it increasingly difficult to recruit and retain faculty and to attract graduate students Although this situation has serious national implications, it is primarily one of a marketplace working as it should, and does not require a massive federal response
Los Angeles Times 6 Jan 82	Professors Quit Engineering Schools Face Brain Drain by Paul Richter	1980	Engineering Faculty	Article	The number of full-time engineering professors has fallen by 2,500, or 15%, in five years Freshmen enrollments in U S engineering programs have surged 89% to 120,000 in the same 5 years Salary offers for B S graduates in engineering average $24,000 a year and range up to $38,000 for petroleum engineers Doctoral students compare this to their $4,000 to $7,000 annual stipend for 4 years and an average assistant professorship salary of $22,000--with no guarantee of tenure or future salary increases

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Defense January 82	Engineer Shortage is Critical by Gen Robert T Marsh, USAF	1980's	Scientists and Engineers	Article	The Air Force Systems Command does not have all the technically qualified and experienced S&Es it needs The shortage hampers the ability of the command to fulfill its mission The military alone cannot solve the problem which is national in scope
Science, Vol 214 18 December 1981	Women Scientists and Engineers Trends in Participation by Betty M Vetter	1973-1978	Women Scientists and Engineers	Article	Women have made tremendous strides in educational attainment in science and engineering over the past decade, increasing their proportion of doctorate awards in these fields from 7 percent in 1965 to 23 percent in 1980 Data are presented in all science and engineering fields
AAAS News 1 January 82	Science and Engineering Graduates Offered Record High Salaries by Eleanor Babco	1981	Science and Engineering Graduates	Article	Recruitment of new science and engineering graduates in 1981 reached record highs with starting salaries hitting new peaks Averages ranged up to $26,650 for bachelor's level petroleum engineers and $35,516 for new Ph D s in electrical and computer engineering Graduates in computer science averaged $20,712, second only to those in engineering at the bachelor's level Chemical engineering graduates at the master's level topped the averages at $26,484.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
Science, Vol 214 27 November 81	Military - Industry Plan Boosts Science Education	1980	Science Education	Article	The Pentagon is providing the initiative for a program designed to promote interest in science and engineering among high school and college students A cooperative effort between the military and industry, the program will work mainly through ROTCs in high schools and colleges
The Washington Post P# D7, 15 December 81	Schools Shrink, Need for Engineers Grows by Robert J Samuelson	1975-1980	Engineering Students	Article	Since 1975, engineering enrollments have risen by about half An engineering shortage would suffocate the economy no less effectively than a fuel shortage Between the late 1960's and the late 1970s, the supply of new engineers barely kept up with retirements and deaths, so that the proportion of engineers in the work force declined

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St Paul Sunday Pioneer Press, 25 May 80	Soviet Youngsters Excel in Math, Science Studies by Ronald Kotulak	1980	US/Soviet High School Students	Article	The first intensive study of the Russian educational system has revealed that Soviet youngsters are 10 times better prepared in mathematics and science than their American counterparts All of the 5 million USSR secondary school graduates in 1978 studied calculus for two years while only 105,000 U S high school students took only one year of calculus in 1976 During their secondary school education, each Soviet student takes 3 years of arithmetic, 2 years of arithmetic combined with algebra, 5 years of algebra, 10 years of plane and solid geometry, and 2 years of calculus The mandatory science courses include 5 years of physics, 1 year of astronomy, 5 5 years of biology, 5 years of geography, 3 years of mechanical drawing, and 10 years of workshop training In contrast, the level of this type of education in U S high schools is declining with only 9 percent of students taking one year of physics, 16 percent taking one year of chemistry, 45 percent taking one year of biology, and 7 percent taking one year of general.sciences
Business Week 14 December 81	Why Industry Must Step in to Train Engineers	1980	Japanese Engineering Students	Article	Japanese universities are turning out record numbers of engineers The recently hired Japanese must continue their education with their companies in what amounts to a complete retraining effort Since Japanese students learn only abstract sciences, industry has no choice but to train its engineers It is not viewed as a serious handicap due to the availability of time to train engineers in Japan's lifetime employment system

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Fortune 11 Jan 82	Why Engineering Deans Worry A Lot by Jeremy Main	1980's	Engineering Faculty and Graduates	Article	Engineering schools are packed with unprecedented numbers of undergraduates, but can't recruit enough teachers for them or enlarge crowded classrooms and laboratories The supply is, however, elastic The engineering labor force is highly flexible and adaptable In bad times, unemployment among engineers is remarkably low When certain engineering skills are in urgent demand, the supply quickly expands People trained as engineers but doing other kinds of work can be recruited back to engineering People not trained as engineers --physicists say, or skilled draftsmen--can do engineering work Engineers trained in one field can often readily adapt to another Engineering schools can expect little help from the government Few state governments have the funds to bolster engineering education The North Carolina legislature has voted $24 4 million to help a consortium of five colleges establish a microelectronics center. The Reagan administration doesn't want to help. It has proposed cutting the NSF funds for science and engineering education from the $112 million requested by Carter to $8 7 million -- just enough to close out the program
The Wall Street Journal # 15 24 Aug 81	Colleges Faltering in Effort to Ease Critical Shortage of Programmers by George Anders	1980	Computer Programmers	Article	There is a continuing bottleneck in the booming computer industry, the shortage of qualified graduates to fill jobs Estimates of jobs available run as high as 54,000, but the nations colleges only graduated 11,000 people with bachelor's degrees in the field last year.

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Army Times 25 January 1982	DOD Study Group Probes U S Technological Tailspin by Tom Philpott	1981	Scientists and Engineers in DOD Laboratories	Article	A DOD study group is looking for ways to reverse a steady decline in quality and numbers of engineers and scientists which soon may eliminate America's technological edge over the Soviet Union With starting salaries for most DOD engineers and many scientists $4,000 to $6,000 below the private sector, the service reported last year an ability to fill less than half of its GS-5 and GS-7 entry level positions
National Science Foundation	Selected Tables on Foreign Graduate Enrollment and Foreign Post - Doctorates in the Sciences and Engineering December 1981	1981	Foreign Sciences and Engineering Graduates	Tables of Data	Data covers foreign graduate students in each science and engineering discipline in terms of level of study, sex, and type of control (public or private)

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Industry/Founder Societies Forum on Engineering Manpower 17-19 January 1982	The Price of Seed Corn by J Thomas Ratchford	1980's	Engineering Faculty and Graduates	Paper	Possible trends are Industry and Government augmentation of science and engineering faculty salaries, reconcentration of R&D in fewer universities, erosion of quality in second-tier universities and colleges more basic research in industry, although we have problems at the university and college level in science instruction and research, it is at the high school level that we face disaster in the short term
The Washington Post 27 December 1981	Government, Industry, Academia, Engineer Shortage Sparks a Once-Unlikely Merger by Thomas W Lippman	1980	Engineers	Article	Arizona State University is developing a $32 million "Center for Excellence in Engineering" that represents a partnership of the state government, the university, and private industry Major electronic and high-technology employers such as Motorola are providing $9 million on the center's funding, enabling ASU to add 60 positions to its engineering faculty, increase teaching salaries, and expand graduate and undergraduate enrollments Several other major schools have set up similar partnerships Stanford, Rennselaer Polytechnic Institute, Carnegie-Mellon, and North Carolina are among the universities that are working with industry to develop or expand their technical education facilities

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American Association for the Advancement of Science 6 January 1982	The Other Frontiers of Sciences by D Allan Bromley	1980 s	Science and Technology	Presidential Address	The U S still has overall, the world's strongest science and technology enterprise, but this strength is in substantial jeopardy This is a time of rapid change in public expectation of science and technology We must build a new public constituency for science and technology We must rebuild science and mathematics in the nation's schools to foster both increased public literacy and the foundations for professional development We should not embark on crash corrective programs, but rather make changes consistent with the time constants involved of the systems involved We must rebuild bridges to the national security and defense enterprise We must rebuild bridges to private industry and help it to focus on the international marketplace

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The Institute of Electrical and Electronics Engineers	IEEE Manpower Information, Letter to Ms Jeanne Carney from Richard J Gowen dated 24 November 1981	1980's	Electrical Engineering Graduates	Letter	There is limited data available concerning engineering manpower needs. A summary of the IEEE workshop on "Engineering Manpower Supply and Demand Examining Relationships" is presented The summary states Industry would rather hire new graduates and train them to support new projects rather than hire experienced engineers, engineering salaries, even for new graduates, have failed to keep up with inflation during the latter part of the decade of the seventies, there is a severe shortage of qualified faculty, especially at the Ph D. level, by retraining existing engineers, the number presently forecasted to be available should be adequate to meet the predicted requirements of industry, a call for an in-depth evaluation of the issue of providing engineering manpower to support the continued national growth.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
National Commission on Research	Accountability Restoring the Quality of the Partnership 1980	1980's	University Research	Report	For the most part of a half century, the federal government and the research universities of the nation have been associated closely in the support and performance of research Recently, this relationship has become strained The partners have developed different views on the objectives of their association and the conditions of their collaboration The conclusions of the report are There is no issue about the need for accountability, the issue is how that accountability is to be rendered, differences between the government and the universities over this issue have caused a deterioration of their relationship, the universities must regulate themselves more effectively, and the government must reduce the detail and volume of its requirements, the management tools currently available to address these accountability problems are inadequate
National Association of State Universities and Land-Grant Colleges	The Doctoral Shortage in Engineering A Growing Crisis by Dr Russel C McGregor	1980's	Engineering Doctorates	Policy Paper	Paper recognizes the need for action and identifies appropriate actions for universities, industry, and government All are well-worn and general

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The Science Teacher May 1981	Science Education's Future The Case for Government Support by Donald W McCurdy	1980's	Scientists and Engineers	Article	The Reagan Administration's OMB proposed cuts in the science education budget of the NSF which would virtually eliminate science education programs from the entire federal government The article argues against such cuts with well-worn NSF rhetoric
National Science Teachers Association	Science and Engineering Education in the U S An Analysis of the NSF-Department of Education Report by Bill G Aldridge undated	1980-2000	Scientists and Engineers	Comment	The deterioration of science education in secondary schools is correctly identified with the following factors The low priority given to science in the schools, the reduction in teaching resources and materials, inadequate teacher salaries, the general lack of support for science teaching The low priority given in our schools is not merely a local or state phenomenon A major share of the responsibility rests with the scientific community, its scientific societies, and the federal agencies which fund science and scientific research

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High School Chemistry Teacher Conference 6 November 1981	Crisis in Physical Science Teaching in High School by Dr Trevor G Howe and Dr Jack A Gerlovich	1980	Secondary School Science and Math Teachers	Report	The report is a summary of the estimated supply and demand of secondary science and mathematics teachers Schools are not getting and keeping the excellent teachers in science and math that are needed Science educators perceive the problem to be a lack of serious commitment by government and the science establishment Supply and demand are directly affected and correlate highly with economic conditions of the nation There are perceived shortages of teachers in the physics, mathematics, chemistry, and earth science fields
The New York Times P# C6, 22 September 1981	The Science Age is Turning Darker by Fred M Hechinger	1980's	Science Education in Elementary and High Schools	Article	This may be the age of science everywhere except in American public schools At least half of all American high school graduates have taken no more science than the minimum requirement of one year of biology and no mathematics beyond algebra In the 1980's, the Japanese education system is much better equipped than its U S counterpart to produce workers with a high level of skill in math, science, and engineering that the economy of the future will require Scientific illiteracy in a world in which science and technology play so great a part seriously undermines the citizen's capacity to understand society

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The Chronicle of Higher Education 16 Sept 1981	Widespread Reports of Faculty Raiding Raise Alarm Among University Officials by Malcolm G. Scully	1980	University Faculty	Article	Twenty-two full professors in the biological sciences have received job offers from private industry Their average salary at Wisconsin was $38,800 The average offer was $56,600 University administrators and department chairmen say that faculty members who are tempted by outside offers are not motivated solely by the prospects of higher salaries While in virtually all of the incidents of raiding, the professors recruited to private fields received more money, they frequently say that increasing academic bureaucracy and deterioration of research facilities play an equally important role in their decision An incredible bureaucracy has been inflicted on all university research everywhere
Comparative Strategy, Vol 1, No 4, 1979	Soviet Economic Problems and Technological Opportunities, by Daniel R. Kazmer	1950-1975	Soviet R&D Personnel	Article	The Soviet leadership has long placed heavy emphasis on the training of natural scientists and engineers In recognition of the importance of these positions in the economy, incentives such as relatively high wages, above-standard housing, and other privileges have been utilized to attract individuals to these occupations Since 1950, the supply of scientists and engineers has grown dramatically The average annual rate of growth of scientists and engineers in R&D is 8 4% in the 1963-75 period The average annual growth of estimated Soviet expenditures on science is over 10%. The best talent has been directed to defense-related activity

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Subcommittee on Economic Goals and InterGovernmental Policy, Joint Economic Committee	Statement of Dr F Karl Willenbrock, 3 Nov 1981	1980s	Electrical, Electronics Engineers and Computer Sciences	Testimony	Electronics companies have grown at a 17% annual rate for the past 10 years Electronics accounts for 46% of the GNP The shortfall between supply and demand of BS/EE and CS engineers projects to 129,000 by 1985 or 25,000 annually To meet the needs of the electronics industry alone, the engineering schools would have to triple their output of EE and CS engineers for each year for the next 5 years The shortage of engineering talent in the U S does not stem primarily from a lack of students, but rather from the shortage of educational resources to educate them The faculty shortage is the most serious problem
American Electronics Assoc	Planting the Engineering Seed Corn by Pat Hubbard Aug 1981	1980s	Engineers	Report	An increasing national shortage of engineers threatens to limit the growth of high technology and negatively impact the continued health and expansion of the electronics industries The shortfall for the electronics industries alone projects to 25,000 EE/CS B S engineers annually through 1985 This shortage is primarily due to a lack of capacity of engineering colleges.
American Electronics Assoc	Technical Employment Projections 1981-1983-1985 May 1981		Professionals and Paraprofessionals	Tables of Workforce Projections	Projections are made by region for employment in professional labor force for electronics engineering jobs Labor categories and educational requirements are listed

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National Occupational Information Coordinating Committee, Bureau of Labor Statistics	The Status of the NOICC/SOICC Network 30 Sept 1980 NOICC Administrative Report No 5 April 1981	1980	All Occupations	Report	The National Occupational Information Coordinating Committee has developed and implemented an occupational information system at the federal, state, and local levels
American Vocational Association	The Shortage of Skilled Workers Undated	1980s	Skilled Workers	Report	Three out of four jobs in the 1980s will require technical training below the B S level Yet more students than ever are dropping out of mathematics and science after the tenth grade, eliminating them from technical careers There is a growing mismatch between the needs of the workplace and the skills of U S workers The post-baby boom generation will provide fewer workers to fill openings due to retirement During the 1980s, there will be a sharp drop in the growth of the labor force from the current 2.3% rate to 1 1% Some 22,000 new machinists and 9,000 tool and die makers will be needed in the U S through 1985. Continued vocational education is mandatory
American Vocational Association	The Vocational Education Enterprise in 1980, A Statement by Dr Gene Bottoms 17 Sept 1980	1980s	Vocational Skilled Labor	Testimony	Public vocational education today serves almost 17 million Americans Vocational education programs are available in schools attended by more than 98% of all high school seniors A detailed description of this network is provided with supporting statistical data.

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American Vocational Association	Statement of Dr Gene Bottoms before the House Banking Subcommittee on Economic Stabilization 24 July 1981	1980s	Vocational Skilled Labor	Testimony	Specific recommendations are made on how to make skill training a part of economic revitalization Very detailed
The Analytic Sciences Corporation	A Preliminary Investigation of Foreign Graduate Technical Student Education in the United States 30 June 1980	1970s	Foreign Graduates of U S Higher Education Institutions	Report	The number of foreign students enrolled in U S institutions of higher education has been increasing steadily since 1945 Since 1964, their numbers have more than tripled The most dramatic increases have been in the number of foreign students enrolled in science and engineering curricula at the graduate level Concern has been expressed that foreign students are replacing Americans in graduate science and engineering programs, technology may be transferred from the U S. to economically competitive or hostile countries through foreign student education, a large proportion of the foreign graduate students' education is financed by U S. government resources Findings are that in 1979 over 260,000 foreign students were enrolled in U.S. colleges, 29% of the foreign students were majoring in engineering and 15% in sciences, foreign students comprised 40% of the total enrollment in engineering at the masters level and 47% at the doctorate degree level, over 40% of foreign graduate students and over 50% of foreign engineering graduate students received financial assistance from the U S universities in the form of teaching and research assistantships, the U S. government sponsors over 3,000 foreign postdoctoral and advanced researchers to study in the U S and more than 25% conduct research in technological and scientific areas.

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SRI International	Education and Employment of Scientists and Engineers in the U S and U S S.R Summary Report and Commentary on Implications for U S National Security Policy SSC-TN-ISR-15 by Catherine P Ailes, Francis W Rushing May 1981	1950-1980	Soviet/ U S Scientist and Engineer Comparisons	Summary Report	The report presents a summary of the findings of a five-year research effort in the comparative study of U S and U S S R training and utilization of scientists and engineers While problems in U S science and engineering education and utilization seem acute, they are even more serious when contrasted with what is happening in the Soviet Union The Soviet commitment to the development of large cadres of highly-trained scientists and engineers is clear, to bring about improvements in the economic sphere and thus increase the chance of Soviet success in its competition with the western world Data are provided on comparative U.S /Soviet curricula in elementary, secondary, undergraduate, and graduate educational institutions Output data are provided In addition, qualitative comparisons are made which, in general, tend to diminish the impact of Soviet quantitative advantages

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American Council on Education	Recruitment and Retention of Full-Time Engineering Faculty, Fall 1980 by Frank J Atelsek, Irene L Gomberg Oct. 1981	1980	Engineering Faculty	Summary of Survey	Findings indicate that most institutions have been unable to recruit and retain a full complement of well-qualified faculty in many fields of engineering Consequently, teaching loads have increased, greater reliance has been placed on teaching assistants and part-time faculty, and the range of course offerings has been reduced in certain subjects Many believ that the quality of research and instruction in engineering colleges is on the decline Data are provided by engineering field Examples are almost 10% of full-time engineering faculty positions were unfilled at the beginning of the fall 1980 term, of these, 45% had been vacant since fall 1979 During 1979-80, almost [illegible]00 full-time engineering faculty voluntarily left academia for full-time employment in industry representing 2.7% of the permanently employed faculty.
National Association of State Universities and Land-Grant Colleges	The Doctoral Shortage in Engineering A Growing Crisis 26 Oct 1981	1980s	Engineering	Policy Paper	There is a critical shortage of doctoral level engineers Enrollment in undergraduate engineering programs has risen steadily and most colleges are operating at enrollment levels which, if sustained over long periods without the infusion of substantial new resources, will result in the erosion of the quality of educational opportunity General recommendations are made for cooperation of academia, industry, and government.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
The Reflector, Boston Section of the Institute of Electrical and Electronics Engineers 1 Feb 1982	How Secure Is Your Job, by Ephraim Weiss	1980s	Electrical Engineers	Article	Many electrical engineers have been laid off within the past few months Recent layoffs are Raytheon's Data Systems Division, 250 DOT's Transportation System Center, 50, GTE's SSP Division, 195, Honeywell's Information Systems Division, 400, Nixdorf, 250, Polaroid, 1,000 A deficit of some 40,000 EE jobs nationwide is projected for 1990 New England experienced a similar situation about ten years ago The projected demand for new EEs up to 1990 is about 172,000 By the year 1990, the annual rate of production of engineers will exceed demand by about 40,000 This means that by 1990 about 40,000 EEs will be unable to find engineering jobs Experience indicates that most of these will be older engineers displaced by younger, less expensive engineers Experience during the early 1970s indicated that manpower studies based on data collected from colleagues were usually at least as reliable -- and always more timely -- than that based on industry or government data

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Corps of Engineers	Developing and Managing the Corps Work Force for Future Missions	July 1980	Corps of Engineers Work Force (12,500 are classified as S&E's)	Published Report	This study analyzes the Corps of Engineers work force requirements for the 1980's and identifies specific actions which will develop the work force to meet these needs. Purpose was to determine the investments in employee development and management that must be made today to assure the Corps will have the personnel resources to meet the challenge of the next decade. Recommendations were (1) Exploit mission opportunities in areas where personnel resources are supported by national interest; (2) Develop the work force by in-house/out-of-house training and by delegating recruitment and career development to the lowest level so we deal with reality (3) Manage the work force better (4) Fill key skill needs (a) Management, (b) Technical, (c) Mission Support, (5) Make a yearly inventory of Corps requirements. One S&E's study indicated over a five-year period, over 65% of S&E's at each level would be new to their job and that increased pressure will produce a shortage of 3400 S&Es at the lower level over a five-year period. Impact on DOD: Shortage could adversely affect all services since Corps is main MILCON agent for Congress

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Ad Hoc Task Group - DUSDRE (P&AT)	Industrial Barriers on DOD Labs	FY 79 HASC Hearing to 9/79	DOD In-House Laboratories	Report	Recommended a single control mechanism be adopted to govern the level of internal laboratory operations, i.e , a dollar ceiling on total civilian payroll of each Lab. This would remove ceiling constraints without allowing Labs to go wild, it would remove high grade constraints since only dollar amount would apply, and it would strengthen the authority of Lab management officials Impact on DOD Would certainly solve many existing problems identifed on questionnaires.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
Hum RRO	Representation and Relative Compensation of DOD Minority and Female Scientists and Engineers	1980-1981 except demographics presented from Dec 75/Dec 79	DOD Minority and Female Scientists and Engineers	Published Report	1. Female S&E's in DOD compared to all other sectors are under-represented across the board, and grossly under-represented in supervisory/managerial (GS-14*) levels 2. Compensation for minority males is about 4% less than non-minority males. 3. Compensation for females is about 9% less 4. Compensation of all groups is about level at entry and become more disparate as a function of age 5. Compensation over a period of time deteriorated in "AF" and "Other DOD" 6. Over a period of time, female promotion was slower than male Impact on DOD Added recruitment emphasis should be placed on EEO and particular attention should be denoted to career mid-level patterns.

N		% of DOD
53,577	N-M Males	89.7
4,060	M Males	6.8
1,782	N-M Females	3.0
316	M Females	0.5

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
ODASD (M, RA & L) (Education and Training)	Report to HASC - Shortage of Graduate Educated Engineer Officers This report 1982	First Report 1981 to undated 1982	Uniformed Engineers	Unbound Report	In recruiting and retaining engineers, the Air is impacted most severely because they use fewer civilian and more uniformed engineers than either the Army or the Navy. They have had great difficulty in meeting graduate officer requirements. AF will exercise the option of paying continuation bonuses Although the Army is experiencing some difficulty, the problem is not as acute as the AF due to extensive use of civilian engineers. Army will not exercise the continuation bonus. The Navy already has pay incentives for categories which include both engineers/non-engineers, i e., submariners. Since the continuation bonus cannot be combined, the Navy will not exercise the option Impact on DOD AF could have to civilianize some fficer engineer categories in order to come . en close to their requirements

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
Joint Logistics Commanders Joint Panel on Civilian Personnel Mgmt	Civilian Engineer Recruitment, Retention and Use Throughout the JLC 30 Oct 81	Mar 80 30 Sep 81	JLC Civilian Engineers AFSC - 4,848 AFLC - 2,234 DARCOM - 8,928 NMC - 21,970	Published Report (Extensive Appendices and Tables)	The JLC identified four perceptions about the JLC civilian engineering force and set out to prove or refute these perceptions a Difficulty in recruiting because Federal salaries were not competitive with the private sector b Recruiting program and methods needed improvement c JLC was experiencing a retention problem d Engineers were not having full use made of their professional skills and abilities All proved to be true but the salaries are non-competitive at the entry levels, Federal salaries are not competitive at mid levels Recommendations included updating their data base for JLC so that data could be used easily, modernize recruiting and centralize it, develop information programs for engineers, encourage pursuit of education, monitor resignations, transfers, and terminations and provide counseling, that JLC managers determine what is engineering work and exercise better position management in writing PD's Impact on DOD Makes some good points on advertising phrases and methodologies from which we could learn

NOTE Part of their data was invalid due to "coding inaccuracies in the Civilian Personnel Data File maintained by the Defense Manpower Data Center, Monterey, California "

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
Individual Al DeLucia	Use of Military Officers as Directors of R&D	Experience during his career (Prior to 12/81)	Rome Air Development Center		Identifies problems which contribute to waste of and manpower through the assignment of military personnel as R&D directors (1) Frequent rotation, (2) Assignments to "broaden" officers, (3) Requirements imposed by OER's, (4) Officers' concern over good IR rating, (5) Lack of continuity and confidence in officers, (6) The view that rotation of command is better than continuity of command, (7) If officers specialize, they may decrease their promotability, (8) The assumption that an officer who can command can also manage an R&D function, (9) The tendancy of the military departments to identify commander positions for officers, (10) The layering of command. To alleviate these problems (1) Strongly de-emphasize the administrative emphasis of IG reviews, (2) Limit responsibilities of military to general items -- not R&D, (3) Return the direction of the development/engineering process to qualified civilians, (4) Restore meaningful responsibilities to civilians, (5) Discourage the idea officers must be experts in N things to get a promotion, (6) Lengthen tours of duty, (7) Insure officers are rotated to meet DOD requirements and not the officers career program, (8) If above changes cannot be made, consider civilianizing all technical positions.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
USAF Scientific Advisory Board	Scientific & Engineering Manpower Shortfalls Within the Air Force	23 Apr 79 30 Oct 79	USAF S&E's	Report and Briefings	Report recommended short-term solutions Find an alternative to "billet validation system" for determining advanced degrees, recall reserve engineering personnel and retain passed-over S&E's, re-examine the mix of civilian versus military S&E's, cross-train qualified officers to serve in engineering and project management, improve morale of S&E's, conduct in-depth exit interviews to find out why; re-examine assignment priorities, examine current requirements, increase inputs to the MS degree program, pursue education incentives to attract and retain S&E's Report recommended long-term solutions, increase money and promotions, increase ROTC inputs, increase the AECP, increase use of AFIT, increase recruiting budget AF response indicates attempts will be made to comply by FY82 Impact on DOD Based on information from AFSD personnel list and results of DOD questionnaire, AF has not been overly successful.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
OUSD	Military-Technology Sharing 5 Oct 81	Jan-Mar 1981	Universities	Correspondence	Early in 1981, DOD opted to place Very High Speed Integrated Circuits (VHSIC) under the International Traffic In Arms Regulation (ITAR) which in effect, bars all foreign nationals other than immigrant aliens from access to data at universities A letter signed by the presidents of five major American Universities was sent to the Secretaries of Commerce, Defense, and State expressing their deep concern regarding such governmental restrictions being placed on research publications and discourse among scholars as well as discrimination based on nationally in employment of faculty and admission of students and visiting scholars Conclusions We do not have adequate information at hand to readily and intelligently answer some of the basic questions There is no national policy on the issue of export control of U S technology and the DOD interim policy has not been finalized National policy should result from interface of government, industry, and academia Possible impact on DOD Labs If enforced could cause pervasive conflict between academic/military communities and cause extreme difficulty in contracting R&D to universities

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
OPM - Classification Task Force	A Federal Position Classification System for the 1980's Apr 81	10-6-80 4-81	Only as it applies to S&E's	Bound Report	1 Recommends Rank-In-Person approach to professional jobs (This is available under RDGEG) 2 Recommends more sensitivity to changes in the market but recommends no definitive way to do so 3 Recommends a separate supervisory grade level pay increase so supervisors would have more money if not a higher grade when they perform supervisory duties Impact on DOD Too little, too late

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
DOD	President Carter's Review of Science and Engineering Education	8 Feb 80 1 Jul 80	Components of DOD	Draft White Paper	DOD assessed material submitted by the three services Problems identified poor secondary level math and science education, fewer people choosing math and science options in college, foreign students, pay caps, high-grade ceilings, the unfavorable career atmosphere presently presented to potential S&E's Recommendations included increasing pay, removing cielings, subsidy of students in graduate school, working with and encouraging universities to maintain their technological base Report indicates Army is short 904 engineers, 273 scientists, AF is short 1180 officers, 744 civilian S&E's, Navy is short 1500 officers, 450 civilians Impact on DOD Labs Continuing

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
DOD LMTF	Report of the DOD LMTF Jul 80	June 1978 Oct 1979 (LMTF formed 1/80)	DOD RD&E Laboratories	First Interim Report	There are significant barriers impeding effective role performance management flexibility, staff, facilities, equipment Recommend LMTF take correction on addressed barriers Personnel and Manpower, Facilities and Equipment, Procurement and Acquisition Within the area of Personnel and Manpower, the following are considered barriers 1 Frequently changing manpower ceilings 2. High Grade Reduction 3 Salary Competition 4 Travel and Transportation Limits 5 Inspections and Audits. Within the area of Facilities and Equipment, the problem was twofold 1. Inadequate modernization of Lab facilities 2 Insufficient modernization and acquisition of Lab equipment In the area of Procurement and Acquisition, three barriers were identified 1 D&F limit and process 2 Contracting 3 Needed improvements in Lab financial management systems. LMTF also recommended essential actions be continued, i.e., 1. Continue work to identify and address remaining barriers 2. Adopt selective application principle for Labs 3. Provide follow-through action at OSD and service levels 4. Monitor progress 5 Assess Lab vitality over time.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
OUSDR&E	Required In-House Capabilities for DOD RDT&E 1 Oct 80	As 1980	DOD RDT&E Establishment	Published Report	Report discusses the responsibilities of the DOD internal research, development, test and evaluation establishment which is comprised of program management offices, laboratories, R&D centers, test and evaluation activities, and other technical organizations These organizations employ 60,000 people and have a total annual budget of approximately five billion dollars This report describes the capabilities of these RDT&E organizations which constitutes the diverse mix necessary to support DOD technological strength requirements

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
Office of the Director of Defense Research & Engineering	The DOD Laboratory Utilization Study by John Allen Rodney E Granthem Donald B Nichols 28 Apr 75	April 1974 April 1975	DOD R&D Labs	Published Report	Study was initiated in response to management objectives stated by SECDEF Study addressed 1 Does DOD really need in-house Labs? 2. If yes, how should the Labs be organized and managed to get the most of them? 3 What is the most appropriate division of effort between the in-house Labs, industry, universities, and other performers in RDT&E programs? 4 What is the proper size of the Lab complex? Results were 1 DOD does need in-house capability 2 Recommendations were made to each service on possible improvements although overall DOD endorsed organization of service Labs 3 DOD study considered too much in-house work being performed particularly in Technology Base Recommended Labs reduce in-house personnel by 3000 in FY76 and 1600 in FY77 and the resultant savings be applied to contracts. 4 Recommended overall decrease of 10% to 15% in the Lab personnel system to take place in FY76 and FY77

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
Congressional Research Service Library of Congress	Engineering Manpower A Survey of the National Problem and the Problem in DOD 21 Dec 81	1981	Engineers in U S and DOD	White Paper	Based on this study and previous studies (notably that of the International Institute for Strategic Studies) the technological edge the U S (West) has held over the Russians (East) has perished so that we may no longer count on quality versus quantity This technological debilitation is viewed as resulting from the shortage of scientists and (more particularly) engineers in the U.S work force, plus the fact that in competition for the scarce commodity (engineers), the market is unfavorable to government Indications are there will be severe shortages of electronic, computer and chemical personnel Bureau of Labor Statistics has projected an annual average of 93,000 job openings in the 1978-1990 time frame. During the same period, BLS predicts the average annual supply will be 77,000 for an annual shortfall of 16,000. Further, the quality of education and educational facilities are questioned, and this trend is seen as continuing because of cutbacks in Federal spending. The military community (DOD) is predicted to have difficulty recruiting and retaining engineers due to pay caps, highgrade ceilings, and better opportunities in industry

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
Human Resources Research Organization	None 27 Mar 81	Various (1976-1980)	DMDC data	Correspondence with extensive tables and statistical data	In response to request for Mr. C W Weatherholt, Director Staffing and Career Management, OSD (MRA&L), provides information on the numbers of engineers in place at the beginning of FY76 and FY80 Also, sent voluntary and total separations for all DOD by year for the FY76-80 by grade groupings
	4 Nov 81				In response to request by Mr Jerry L. Calhoun, Deputy Assistant Secretary of Defense, Civilian Personnel Policy, provides data on starting salaries for BS level engineers in DOD versus industry
	1 Dec 81				Additional response to above. Compares DOD salaries to a national Batelle survey of salaries paid to more than 50,000 engineers engaged in R&D and a salary survey of over 150,000 engineers conducted by American Association of Engineering Societies
	8 Jan 82				In response to oral request by Mr. Jerry L. Calhoun, Deputy Assistant Secretary of Defense, Civilian Personnel Policy, provides statistics on accessions and separations of engineers/scientists as a function of grade and age.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
The Chronicle of Higher Education	Reagan Budget Would Cut Student Aid, Arts and Humanities Funds by One-Third 17 Feb 1982	1982	Basic Research	Article	Reagan's budget for FY 1983 would provide a dramatic increase in basic research spending, 19 2%, in defense-related projects Except for the Dept of Defense, the research budgets of most federal agencies would barely keep pace with inflation DOD basic research would increase from this year's $694 6 million to $828 1 million in fiscal 1983 By contrast, the research budget of the National Science Foundation would increase by 8 3%, from $974 5 to $1 05 billion
The Chronicle of Higher Education	Soviet Officials Forced to Cajole Students to Take Science Courses 20 Jan 1982	1982	Soviet Scientists and Engineers	Article	Boris Melnik, Rector of Kishinyov University, a typical provincial institution on the Rumanian border said that he had to cajole students into applying to study science "Over the past ten years, we have seen a clear decline in enthusiasm for the natural sciences and technical disciplines compared with the humanities. This has been noticed by my colleagues all over the country "
The Chronicle of Higher Education	Engineering Schools Urged to Forge Industry Links 14 Oct. 1981	1981	Engineers	Article	The National Academy of Engineering told Congress that universities could help eliminate the severe shortage of engineering faculty members if they conducted more research directly applicable to industry, encouraged professors of engineering to serve as consultants to industry, and required their faculty members to have real industrial experience

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
Scientific Manpower Commission	Supply and Demand for Scientists and Engineers Jan 1982	1980's	Scientists and Engineers	Review of Available Studies, Estimates of Supply/Demand for All Major S&E Disciplines	At present, there are no accurate predictive models, or even any that have consistently worked well in the past Some trends in scientific and engineering manpower supply and demand seem fairly certain Except in computer science, the supply of most scientists appears to have caught up with, and generally exceeded the number of job opportunities in science There is disagreement as to whether the supply of engineers will exceed the demand in the 1980's, or whether there will be shortages in at least some engineering disciplines The number of new engineers graduating at the baccalaureate level has been rising since 1975, and the increase can be expected to continue at least through 1985 A high level of demand has not only fueled that increase, but has utilized so many engineering graduates at the B S level that graduate enrollments of U S students have not climbed commensurately, and shortages of Ph D engineers have become serious in academic institutions. The general levels of funding from both industry and government to support research and development will be major determinants of actual demand
The Boston Globe	High Tech Faces a Crisis in Personnel 9 Feb 1982	Present	Engineering Universities	Article	A wealthy industry's insatiable appetite for young, bright engineers cannot be met by resource-poor universities and colleges working with 20-year old, obsolete equipment and an aging, overworked faculty The Massachusetts High Technology Council will formally ask its 110 members to ante up 2% of their research and development expenditures to engineering education, about $14 million Each company will choose how to spend its funds Data General and Wang Laboratories donated $30 million worth of computer systems to the University of Massachusetts and the University of Lowell Computervision Corporation donated $500,000 of computer-aided design systems Analogic Corp. donated $2 million for an undergraduate MIT product innovation program

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
Naval Personnel Research and Development Center (NPRDC)	Effects of the High-Grade Limitation on Navy R&D Center, August 1981	Present	High-Grade (GS-13 through 15) Scientists and Engineers in Navy R&D Centers	Report	Examines the accumulated effects of high-grade promotion limitations in Navy R&D Centers resulting from factors such as workload, attrition, average age for promotion and grade distribution Projections were made for high-grade vacancies, promotion and attrition rates and grade distribution in Navy R&D Centers under alternative high-grade ceiling and retirement policy scenarios GS-12 is still a major bottleneck due to factors listed. There are not enough high-grade personnel to conduct research and management.
Chief of Naval Material (CNM)	CNM Corporate Review, Impact of High-Grade Restriction on R&D Center Scientists and Engineers, 28 May 1981	Present	High-Grade (GS-13 through 15) Scientists and Engineers in Navy R&D Centers	Paper	Addresses impact of reduced high-grade ceilings Impacts include log jam at GS-12 level, reassignments, retention of top performing S&E at all grade levels, technical effectiveness of R&D Centers, increase in costs and quality of doing work; impaired recruiting, less fleet support.
Center for Naval Analyses (CNA)	Navy Civilian Career Development System (In Process)	Present	Technical, Scientific and Engineering Personnel	Report	Will develop a number of models reflecting different management philosophies for career development which could be applicable to the Navy. To develop a critical assessment of the cost and benefits of options for the development program for technical, scientific and engineering personnel.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
National Science Foundation	Planning Session Federal Interest in Minority Participation in Science and Engineering 9 Feb 1982	1982	Minorities and Women Scientists and Engineers	Proposals	The document contains proposals of the National Science Foundation to promote the full participation of minorities and women in science and engineering On September 15, 1981, President Reagan signed an Executive Order to strengthen the capacity of historically black colleges and universities to provide quality education. The NSF is participating in the development of a federal program to achieve a significant increase in participation by these institutions in federally-sponsored programs The primary focus of the foundation's activities is the performance of research carried out by the scientists and engineers in the nation's colleges and universities. Data are supplied on minority-focused programs, employment, and enrollments in the nation's primarily black universities.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
John R Wales Capt U S N (Ret)	Background Paper Navy Engineering Manpower Requirements 1 Oct 1980	Present	Military and Civilian S&E	Paper	Provides data and existing information on military and civilian career paths Raises questions to be answered in a formal study to be conducted No conclusions
Naval Sea Systems Command (NAVSEA)	Recruitment and Retention of Engineers in the Naval Sea Systems Command 21 Jan 1980	1980s	Engineers	Report	Documents NAVSEA's concern of recruiting and retention of engineers in the 1980s Discusses national trends, recruitment at EIT level and mid level, NAVSEA career development recommendation and retention
NRC	Assessment of Civilian Personnel Management and Equal Employment Opportunity Issues October 1981	Present	Civilian Employees	Report	Identifies current and long-term research needs associated with civilian personnel management and EEO, to hopefully have a positive effect on productivity and efficiency Ten major areas were identified for research work including staffing, classification/compensation, supervisory effectiveness, military/civilian relationship, line/staff relationship, EEO, manpower considerations, training, labor relations and personnel management evaluations In other words - need more study

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
Air Force - Manpower and Personnel Staff	Report of Conference on Educational Incentives to Attract and Retain Engineers Aug 17, 1979	Current	Air Force	Report	This was an early effort by the Air Force to structure and implement new programs to attract and retrain engineers Over ten initiatives were reviewed Many of these are now in place (1982)
Air Force - Scientific Advisory Board (SAB)	Report of Ad Hoc Committee of the AF SAB to Study the Growing Shortage of S&E Personnel Oct 1979	Current and Future	Air Force	Report	This is a report of the recommendations made by the AF SAB from its study of the S&E shortage The SAB met in May and September 1979 The Committee supported the fact that the AF had a real shortage of S&E personnel It made a list of short-term and long-term recommendations Many of these have been implemented by this date (1982)
Air Force - Manpower and Personnel Staff	Air Force Summary Response to the AF SAB Report May 1980	Current and Future	Air Force	Report	This report responded to the SAB study and report identified above The response evaluates each of the SAB recommendations, concurring or disagreeing with explanations

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
Air Force - Institute of Technology	Report on Critical Issue Affecting Engineering Manpower in the AF May 1980	Present	AF S&E Needs and National Supply Factors	Report	This study, prepared by Dr J. S Przemieniecki, Dean, School of Engineering, AFIT, outlined the current AF S&E shortage at 3,200 (1980) It provides a slate of recommended actions to help the problem Two unique recommendations are to increase use of engineering technologists and special professional skill programs at AFIT of 6-9 months duration in shortage skill speciality areas
Air Force - Systems Command	Critical Shortage of Scientists and Engineers Dec 10, 1980	Present	S&E Personnel in AF and National Trends	Speech	This was a speech to the American Defense Preparedness Agency's Conference on the S&E shortage, Sheraton National Hotel, Arlington, Virginia Gen Slay outlined a decrease in manning of S&E personnel in the Systems Command, plus the loss of specialists and personnel with experience He further discussed trends in academia, industry and government that showed decrease in production of S&E personnel especially at the M.S and Ph D levels This was one of the early efforts to raise the S&E issue to the national level
Air Force - Institute of Technology	The State of Education Dec. 1980	Present	U S Secondary and College Education	Report	This study, prepared by J W Carl of the AF Institute of Technology for presentation to the ADPA Conference looks at the state of U.S. education, first in the context of America's health and secondly that part of academia pertaining to engineering and technology in the AF Many charts show declining trends of test scores, college students with advanced degrees, etc.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
HQ USAF Office of Long Range Planning	The Engineering Shortage - A National Problem 1981	Current and Future	National and Air Force	Briefing	This is one of a series of briefings prepared during 1981 by Major Jim Graham outlining national supply and demand projections, compensation, implications potential solutions These data provide much of the back-up for Air Force policy decisions and testimony to Congress
HQ USAF Office of Long Range Planning	Engineering in the Eighties 1981	1980's	National and Air Force	Briefing	This briefing contains long range strategies for the AF to overcome its shortages in S&E officers. It includes much data contained in the briefing mentioned above, plus specific initiatives to be undertaken by the AF
HQ USAF Office of Long Range Planning	Critical Skills - A Look Ahead 1981	1980's	National and Air Force	Briefing	This briefing focuses on critical skills needed by the AF in the 80's and includes data on demographics, trends and implications of a broad range of critical skills such as aircraft mechanics, avionics technicians, electronics/computer technicians, machinists/tool and die engineers.

Name or Organization Conducting Study	Title Date	Time Period Addressed by Study	Population Studied	Type of Study	Results
Air Force - Air Command and Staff College	The Engineer Shortage An Analysis May 1981	Current and Future	Air Force	Study/ Report	This report is the result of a student research project at AC&S college It traces national demand for engineers since WW II, outlines the roles of AF officers as engineers, sizes the Air Force shortages, projects the future shortages and suggests possible solutions
HQ USAF	Request for Data on AF Engineering Shortage Oct. 1981	Current and Future	Air Force	Letter w/Data	This is a compilation of data on the Air Force S&E shortages, provided to the Congressional Research Service CRS was undertaking a study of the national S&E problem at the request of Congressman Skelton
AF Systems Command	Shortage of S&E in the AF Nov 1981	Current and Future	Air Force	Speech	This was a speech to AFCEA by Gen Marsh, Commander, AFSC The speech covered current issues in electronics and C^3, but focused on the S&E shortage problem and requested industry assistance

APPENDIX G
ORGANIZATIONAL RELATIONSHIPS

APPENDIX G

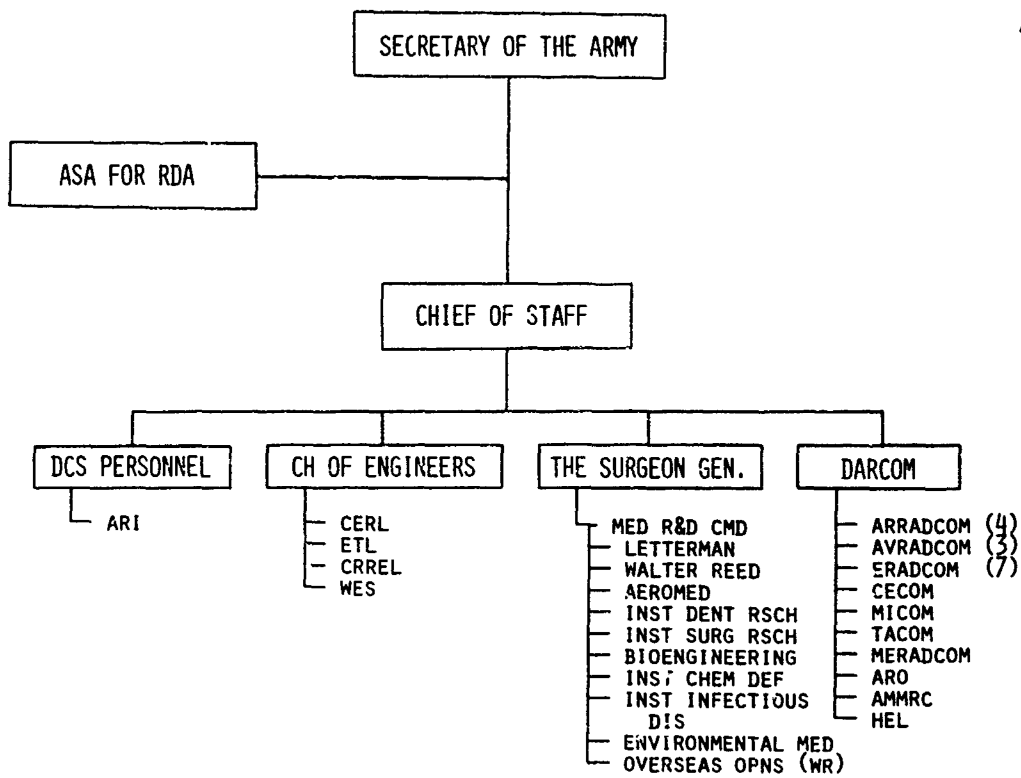
APPENDIX G

ORGANIZATIONAL RELATIONSHIPS

ARMY ORGANIZATION CHART SYMBOL LIST

AEROMED	Aeromedical Research Lab
AMMRC	US Army Materials and Mechanics Research Center
ARI	Army Research Institute
ARO	US Army Research Office
ARRADCOM	US Army Armament R&D Command
AVRADCOM	US Army Aviation R&D Command
CECOM	US Army Communications and Electronics Command
CERL	Construction Engineering Research Labs
CRREL	Cold Regions Research and Engineering Lab
ENVIRONMENTAL MED.	Research Institute of Environmental Medicine
ERADCOM	US Army Electronics Research and Development Command
ETL	Engineer Topographic Labs
INST DENT RSCH	Institute of Dental Research
INST INFECTIOUS DIS	Medical Research Institute of Infectious Diseases
INST SURG RSCH	Institute of Surgical Research
LETTERMAN	Letterman Army Institute of Research
MED R&D CMD	Medical R&D Command
MERADCOM	US Army Mobility Equipment R&D Command
MICOM	US Army Missile Command
OVERSEAS OPNS (WR)	Overseas Operations Branch
TACOM	US Army Tank-Automotive Command
WALTER REED	Walter Reed Army Institute of Research
WES	Engineer Waterways Experiment Station

ARMY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MED R&D CMD
LETTERMAN
WALTER REED
AEROMED
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INST SURG RSCH
BIOENGINEERING
INST CHEM DEF
INST INFECTIOUS DIS
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DARCOM
ARRADCOM (4)
AVRADCOM (3)
ERADCOM (7)
CECOM
MICOM
TACOM
MERADCOM
ARO
AMMRC
HEL

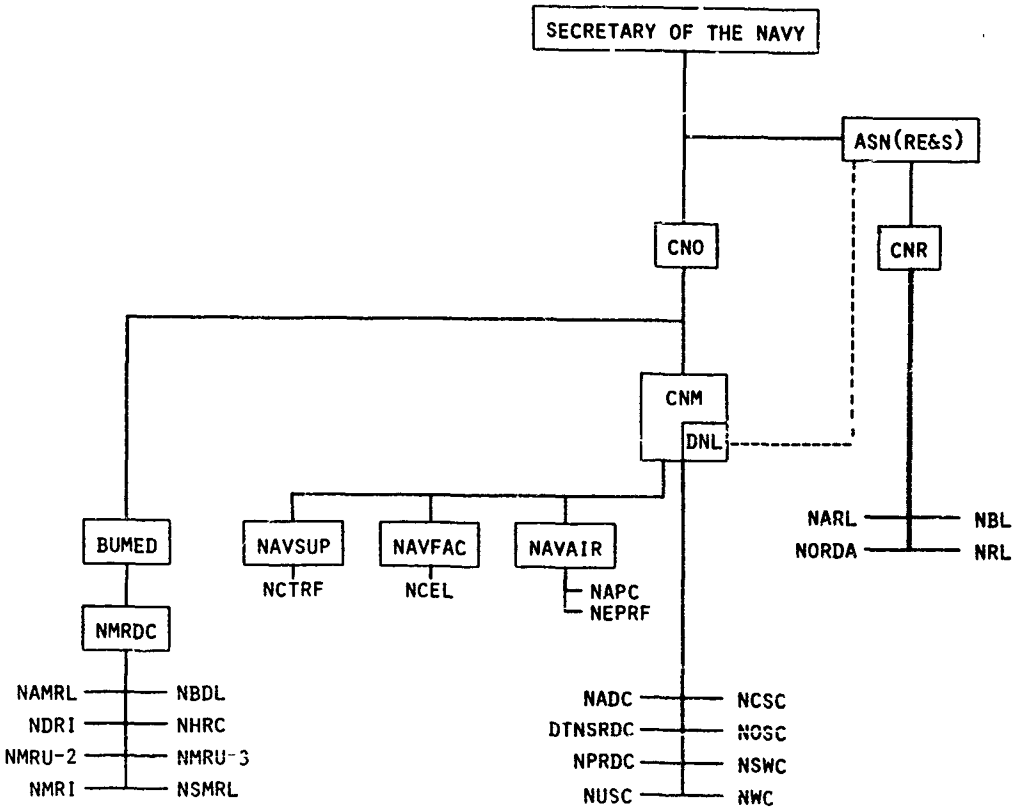
NAVY ORGANIZATION CHART SYMBOL LIST

ASN (R, E&S)	Assistant Secretary of the Navy (Research, Engineering and Systems
BUMED	Bureau of Medicine and Surgery
CNM	Chief of Naval Material
CNO	Chief of Naval Operations
CNR	Chief of Naval Research
DNL	Director of Navy Laboratories
NADC	Naval Air Development Center, Warminster, PA
NAMRL	Naval Aerospace Medical Research Laboratory, Pensacola, FL
NAPC	Naval Air Propulsion Test Center, Trenton, NJ
NARL	Naval Arctic Research Laboratory, Pt. Barrow, AK
NAVAIR	Naval Air Systems Command
NAVFAC	Naval Facilities Engineering Command
NAVSUP	Naval Supply Systems Command
NBDL	Naval Biodynamics Laboratory, New Orleans, LA
NBL	Naval Biosciences Laboratory, Oakland, CA
NCEL	Naval Civil Engineering Laboratory, Port Hueneme, CA
NCSC	Naval Coastal Systems Center, Panama City, FL
NCTRF	Navy Clothing and Textile Research Facility, Natick, MA
NDRI	Naval Dental Research Institute, Great Lakes, IL
NEPRF	Naval Environmental Prediction Research Facility, Monterey, CA
NHRC	Naval Health Research Center, San Diego, CA

NAVY ORGANIZATION CHART SYMBOL LIST (Cont.)

NMRDC	Naval Medical Research and Development Command, Bethesda, MD
NMRI	Naval Medical Research Institute, Bethesda, MD
NMRU-2	Naval Medical Research Unit-2 (Manila, Philippines and Jakarta, Indonesia)
NMRU-3	Naval Medical Research Unit-3 (Cairo, Egypt)
NORDA	Naval Ocean Research and Development Activity, Bay St. Louis, MO
NOSC	Naval Ocean Systems Center, San Diego, CA
NPRDC	Naval Personnel Research and Development Center, San Diego, CA
NRL	Naval Research Laboratory, Washington, DC
NSMRL	Naval Submarine Medical Research Laboratory, New London, CT
NSWC	Naval Surface Weapons Center, Dahlgren, VA
NUSC	Naval Undersea Systems Center, Newport, RI
NWC	Naval Weapons Center, China Lake, CA

NAVY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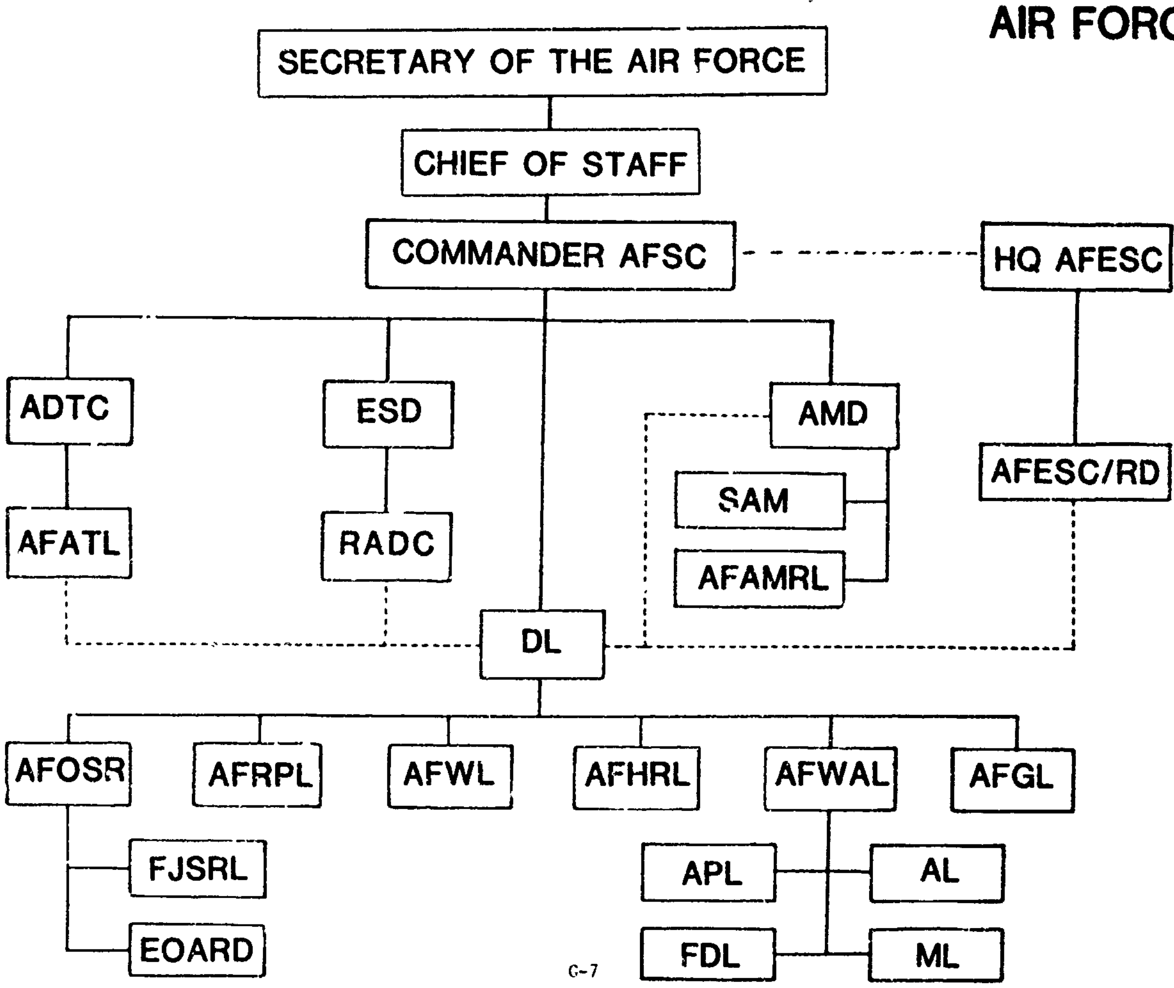
AIR FORCE ORGANIZATION CHART SYMBOL LIST

ADTC	Armament Division
AFAMRL	Air Force Aerospace Medical Research Laboratory
AFATL	Air Force Armament Laboratory
AFESC	Air Force Engineering and Services Center
AFESC/RD	Engineering and Services Laboratory
AFGL	Air Force Geophysics Laboratory
AFHRL	Air Force Human Resources Laboratory
AFOSR	Air Force Office of Scientific Research
AFRPL	Air Force Rocket Propulsion Laboratory
AFSC	Air Force Systems Command
AFWAL	Air Force Wright Aeronautical Laboratories
AFWL	Air Force Weapons Laboratory
AMD	Aerospace Medical Division
APL	Aeropropulsion Laboratory
DL	HQ AFSC Director of Laboratories
EOARD	European Office of Aerospace Research and Development
ESD	Electronic Systems Command
FDL	Flight Dynamics Laboratory
FJSRL	Frank J. Seiler Research Laboratory
ML	Materials Laboratory
SAM	USAF School of Aerospace Medicine

AIR FORCE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