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ABSTRACT

This report consists of two parts. Part 1 provides an inventory of past and present funding instruments in support of university research. It lists types of grants used for research-related purposes and gives information about their provisions and uses. Part 2 provides an assessment conducted by the General Accounting Office of the comparative values of several major categories of funding mechanisms and their impact on research performance and quality. Chapters in part 1 concern background information, direct support of research, the research infrastructure, objectives, scope and methodology, federal funding mechanisms in support of university research, trends in federal support for university research and funding mechanisms used by seven nonprofit foundations and associations. Appendices in part 1 include: (1) "Data Elements of Federal Funding Mechanisms"; (2) "Individual Project Support"; (3) "Program Support"; (4) "Center Support"; (5) "Special Training Needs"; (6) "Major Equipment and Facilities"; (7) "Institutional Support"; (8) "List of Awards by Mechanism and Agency"; (9) "Definitions of Funding Categories"; and (10) comments by various agencies. Chapters in part 2 include information on background, the role of funding mechanisms in improving the quality of university science and the role of funding mechanisms in the performance of research. An appendix provides a summary of scientific responses to selected questions. (CW)

[COMMITTEE PRINT]

SCIENCE POLICY STUDY BACKGROUND REPORT NO. 11

ALTERNATIVE MECHANISMS OF RESEARCH SUPPORT: INVENTORY AND ASSESSMENT

REPORT

PREPARED BY THE

GENERAL ACCOUNTING OFFICE

TRANSMITTED TO THE

TASK FORCE ON SCIENCE POLICY

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

NINETY-NINTH CONGRESS
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LETTER OF TRANSMITTAL

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC, October 14, 1986.

To the Members of the Science Policy Task Force:

From its inception, our Task Force has taken an interest in the matter of the funding mechanisms used to provide financial support for :ientific research. Our interest is focused on how various funding mechanisms affect the conduct of research and impact the institutions who provide the support and those who conduct the research. To provide a basis for our examination of those issues, we are glad to submit for your consideration a report which we requested from the General Accounting Office entitled "Alternative Mechanisms of Research Support: Inventory and Assessment".

The GAO Report consists of two parts. Part I provides an inventory of past and present funding instruments. It lists those types of grants used for various research-related purposes and gives information about their provisions and uses. Part II provides a useful assessment conducted by the GAO of the comparative values of several major categories of funding mechanisms and their impact on research performance and quality. Although limited in scope, this assessment provides a useful first step in the important process of providing an in-depth and continuing approach to the evaluation of funding mechanisms.

We are indebted to the GAO for providing us with this two-part study. At the GAO Mr. Mark Nadel and Sarah Frazier supervised the preparation of both reports. Mr. John Perhonis and Ms. Kathryn Weldon were responsible for compiling the catalog of funding mechanisms and analysing the results, while the assessment was designed and carried out Ms. Nancy Donovan, Ms. Ilene Pollock, and Mr. Greg Andrevitch.

We commend this study to the attention of the members of the Science Policy Task Force, the members of the Committee on Science and Technology, and the interested members of the Congress.

MANUEL LUJAN, JR.,
Ranking Republican Member.

DON FUQUA,
Chairman.

LETTER OF SUBMITTAL—PART I

U.S. GENERAL ACCOUNTING OFFICE,
RESOURCES, COMMUNITY, AND
ECONOMIC DEVELOPMENT DIVISION,
Washington, DC, February 13, 1986.

Hon. DON FUQUA,
Chairman, Committee on Science and Technology, House of Representatives, Washington, DC.

DEAR MR. CHAIRMAN: In accordance with your request and subsequent discussions with your office, this report provides information on federal funding of university research by presenting the array of funding mechanisms used by federal agencies in funding such research.

We are sending copies to the Director, Office of Management and Budget, the heads of federal agencies from which we collected data, and other interested parties. We will also make copies available to others upon request.

Sincerely,

J. DEXTER PEACH,
Director.

LETTER OF SUBMITTAL—PART II

U.S. GENERAL ACCOUNTING OFFICE,
RESOURCES, COMMUNITY, AND
ECONOMIC DEVELOPMENT DIVISION,
Washington, DC, February 7, 1986.

Hon. DON FUQUA,
Chairman, Committee on Science and Technology, House of Representatives, Washington, DC.

DEAR MR. CHAIRMAN: As requested in your November 2, 1984, letter, we have assessed the impact of funding mechanisms on the productivity and performance of university research. This report discusses the role particular funding mechanisms played in helping universities improve program quality and different effects individual project grants and center grants had on the performance of research.

We are sending copies of this report to appropriate committees of both Houses, the Director of the Office of Management and Budget, the Director of the Office of Science and Technology Policy, and the chief officials of the following federal agencies: the Departments of Agriculture, Energy, and Defense; the National Aeronautics and Space Administration; the National Institutes of Health; and the National Science Foundation. We are also making copies available to interested organizations and individuals.

Sincerely,

J. DEXTER PEACH,
Director.

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PART 1

FEDERAL FUNDING MECHANISMS IN SUPPORT OF UNIVERSITY RESEARCH

Executive Summary

The nation's universities play a vital role in advancing U.S. economic health by performing nearly half of its basic research that provides the foundation for technological progress. Federal funds support approximately two-thirds of this university-based basic research. As reported by the National Science Foundation, the federal government, in fiscal year 1984, expended approximately $5.5 billion at universities for research and development, of which approximately $4 billion was for basic research.

The federal government transfers funds to universities and colleges through various "funding mechanisms" that support both research and the infrastructure of research (major equipment and facilities, special training needs, and institutional support). A funding mechanism is a category of federal financial support for scientific research performed at and by U.S. universities. Within the last decade concern has grown that the current array of funding mechanisms may not adequately provide for the continuity and stability of research, the modernized equipment, and the human resource needs to maintain the vital role the universities play in the nation's research effort.

The House Committee on Science and Technology asked GAO, among other things, to describe the

- federal funding mechanisms used, including relative magnitudes of support, by the six federal agencies that support most of the scientific research at universities and
- trends indicating how the use of these mechanisms has changed over time.

In addition, the Committee asked GAO to assess the relative merits of different funding mechanisms. GAO plans to provide this assessment as a separate report.

Background

Six federal agencies represented about 90 percent of total federal budget authority for scientific research performed at universities and colleges in fiscal year 1984: the National Institutes of Health (NIH), the National Science Foundation (NSF), the Department of Energy (DOE), the Department of Defense (DOD), the National Aeronautics and Space Administration (NASA), and the Department of Agriculture (USDA).

These agencies obligate these funds through a variety of types of awards, with different agencies using different kinds of awards or distinct forms of the same award.

To facilitate analysis of the variety of awards and to overcome differences in terminology among agencies, GAO asked the agencies to report data within six categories of funding mechanisms. These six mechanisms can be divided into two groups. The first group consists of three funding mechanisms that directly support research, while the second group supports the research infrastructure. Federal support for research equipment and graduate student training are provided both through the direct support of research and through the research infrastructure.

Results in Brief

In fiscal year 1984, these six federal agencies awarded 89 percent of their research funds through three funding mechanisms that directly support research (individual project, program, and center). Of these three, individual project support dominated, receiving approximately 71 percent of the total. Direct support through programs and centers totaled 18 percent. The remaining 11 percent of total funding went to support the infrastructure of research.

Trends in federal support for scientific research at universities from 1963-1982 show that federal funds directly for research have increased, while funds for the research infrastructure have declined.

GAO Analysis

Array of Funding Mechanisms

The six agencies reported variations in award purpose, in award size and duration, and in the decision process used to select awardees under individual project support. Some individual project awards, for example, are specifically designed for new or young investigators, while others support experienced researchers wishing to develop new research expertise. Award duration varies from 1 or 2 years to 5 years.

Agencies described research conducted under program and center support as often interdisciplinary in nature and related to an overall larger research goal or program, with projects longer in duration and larger in dollar size. For example, DOD uses research contracts to support groups of investigators performing research across disciplines in electronic sciences. NIH's Specialized Research Center Award supports core research facilities and associated projects for a multidisciplinary attack on a specific disease.

The three funding mechanisms that support the research infrastructure received the least emphasis across the six agencies in fiscal year 1984. Of these, institutional support received 5 percent of total funding, due mostly to USDA's formula awards. Major equipment and facilities, as well as special training needs, received less emphasis than institutional support (2 percent and 4 percent of total funding, respectively). (See chapter 2.)

Funding Trends

According to the latest data available from NSF, federal funding for university research and development has grown between 1963 and 1982 from $1.8 billion to $2.5 billion in constant 1972 dollars. Direct support for research received 25 percent more of the total obligations, and the research infrastructure 25 percent less, in 1982 than in 1963. Direct support has increased in constant 1972 dollars from $1.1 billion in 1963 to $2.2 billion in 1982, while support for the research infrastructure has decreased from $688 million to $331 million over the same time period. (See chapter 3.)

Recommendations

GAO is making no recommendations.

Agency Comments

The agencies generally commented that the report was informative and useful. Several agencies specifically pointed out that the research infrastructure is supported by all six federal funding mechanisms in that research projects generally provide for some equipment purchases and graduate research assistantships.

All six agencies suggested technical and editorial changes to the report. We have incorporated these changes, where appropriate, into the report. Agency comments are contained in appendixes X-XV.

Abbreviations

AEC	Atomic Energy Commission
AREA	Academic Research Enhancement Award
Assoc.	Association
BRSG	Biomedical Research Support Grant
D.D.S.	Doctor of Dental Science
D.O.	Doctorate in Osteopathy
DOD	Department of Defense
DOE	Department of Energy
FFRDC	Federally Funded Research and Development Center
GAO	General Accounting Office
HHS	Department of Health and Human Services
JSEP	Joint Services Electronics Program
M.D.	Doctor of Medicine
NASA	National Aeronautics and Space Administration
NCR	National Commission on Research
NIH	National Institutes of Health
NRSA	National Research Services Award
NSF	National Science Foundation
PAD	Program Analysis Division
Ph.D.	Doctor of Philosophy
PHS	Public Health Service
R&D	Research and Development
S/E	Science/Engineering
SRI	Stanford Research Institute
USDA	United States Department of Agriculture

Chapter 1

Introduction

The United States is unique among major industrialized nations in relying primarily on its universities for performing basic scientific research. The relationship between the federal government and the universities has often been described as a partnership that results from an explicit policy to couple scientific research and the graduate education of scientists, and to support that coupling through federal funds. This partnership is considered to be a vital source of U.S. strength in science and technology.

In carrying out its role in the partnership, the federal government supports university research through an array of funding mechanisms. For purposes of the report, a funding mechanism is a category of federal financial support for scientific research performed at and by U.S. universities and colleges. Funding mechanisms differ in the scope of research supported, the types of recipients, and the purposes for which federal funds may be used. Although funding mechanisms differ in these ways, they are similar in that they can support research equipment and graduate students. Below are six funding mechanisms federal agencies use that either directly support research or support the infrastructure of research.

Funding mechanisms are important to the scientific enterprise for several reasons. According to a 1980 National Commission on Research (NCR) study of funding mechanisms, collecting information on the forms of support used by federal agencies is important because the relative emphasis placed by various agencies on the differing forms of support is a statement of federal research policy.[1] In addition, the Science Policy Task Force of the House Committee on Science and Technology, which prepared an agenda in 1984 for the study of government science policy, stated that funding mechanisms have a profound effect on all aspects of the scientific enterprise, and are the focus of continuing discussion and debate. The task force also stated in that report that the diversity of funding mechanisms has gradually narrowed in the last 20-30 years toward the current reliance on one dominant mechanism, the individual project grant. The problems cited by the task force study with the project grant system, such as disproportionate workload in reviewing proposals and in reporting financial information have raised a question whether "the trend toward sole reliance on project grants should be reversed in favor of a system that increasingly uses a greater diversity of funding mechanisms that more closely meet the needs of scientific research."[2]

Federal Funding Mechanisms

A funding mechanism is a category of federal financial support for scientific research performed at and by universities and colleges. We have identified six funding mechanisms that fall into two groups, direct support of research and the infrastructure of research.

Direct Support of Research

1. Individual Project Support
   - support for research under the direction of a principal investigator or co-investigators. Support may include funding for graduate student assistants., equipment, travel, salaries, etc.;
   - research in a discrete research area and of limited duration.

2. Program Support
   - support for research under the direction of more than one principal investigator, each conducting research projects related to an overall objective;
   - broad coherent area of research, often multidisciplinary and long term.

3. Center Support
   - research projects are coordinated into a coherent program in a particular broad field of interest at a university.
   - core funding for equipment, facilities, and administrative unit called a research center.

Research Infrastructure

4. Special Training Needs
   - scientific human resource development specifically through fellowships, traineeships, and training grants.

5. Major Equipment and Facilities
   - purchase of major research equipment or instrumentation and construction of buildings for research.

6. Institutional Support
   - usually unspecified support to enhance research capability and training, often through formula or block grants.

In order to assess the proper balance or mix of funding mechanisms necessary to meet the needs of scientific research, it is important to have information on the array of funding mechanisms that currently exist within the federal system. For this reason, the House Committee on Science and Technology asked GAO to describe the array of federal funding mechanisms and to assess their relative merits. A separate GAO report assesses the relative merits of different funding mechanisms. This report describes the array of mechanisms including the relative magnitude of support of the mechanisms.

Background

We have classified, for purposes of this report, funding mechanisms into two groups, one that contains mechanisms that support research directly (types of research projects) and the other that supports the infrastructure of research (major equipment and facilities, special training needs, and institutional funding). Direct support of research means support for the research project or projects, whereas the infrastructure means support directed at research-related areas, such as major equipment and special training needs that are not tied to a specific project or projects.

Federal support for research equipment and the training of graduate students, however, may be accomplished through both the direct support of research and the research infrastructure. The direct support of research (individual project, program, or center) allows for specific equipment purchases related to research projects and the support of graduate students working on a specific project. Similarly, the infrastructure of research supports equipment purchases that are not tied to any one research project and that generally cost more, and also supports graduate students through specific training awards, such as fellowships, traineeships, and training grants. A brief discussion of these two groups and the six funding mechanisms classified under them follows.

---

[1]National Commission on Research Funding Mechanisms Balancing Objectives and Resources in University Research 1980, p. 5.

[2]An Agenda for a Study of Government Science Policy Report prepared by the Task Force on Science Policy, transmitted to the Committee on Science and Technology, U.S. House of Representatives, 1984, p. 49.

Direct Support of Research

Three funding mechanisms directly support research by allowing universities to perform scientific research ranging from the small research project proposed by an individual investigator to the research center that allows the university to coordinate research projects into a coherent research area with the help of "core" funding for equipment, facilities, and administrative personnel. The three mechanisms are: individual project support, program support, and center support.

Individual project support describes funding for a research project managed by a single university researcher called a principal investigator or several researchers called co-investigators. Such funding is usually awarded on the basis of a scientific peer review for a proposal introduced by the investigator or co-investigators. According to the NCR study on funding mechanisms, projects of this kind are usually conducted within disciplinary departments of a university, and they support basic research. Program and center support, on the other hand, describe support for a research area that is managed by more than one principal investigator, is often interdisciplinary in nature, and is conducted across university departments. The average award size of project supported through these mechanisms is larger and, in the case of center support, research is conducted within special university "centers."

All three types of project support provide for equipment and training that is related to the specific research project or projects. Some agencies, for example, such as NSF and NIH, fund most university research equipment through project support. NSF has informed us that individual project support also provides for the infrastructure through indirect cost allowances for such items as use allowances or depreciation for buildings and equipment and for a portion of the top-level administrative expenses.

Three important characteristics of the three funding mechanisms under the direct support of research relate to the stability and continuity of research, the process that determines who gets an award, and the costs of research that a university is either reimbursed for as indirect costs, or is asked to share (cost sharing). This report addresses the above three areas for the three funding mechanisms that directly support research by describing (1) how long awardees can expect to receive agency funding, (2) how agencies decide who gets an award, and (3) how cost sharing and indirect costs are decided. In addition, appendixes II-VII identify these characteristics for each of the six funding mechanisms by agency and award type as well as describe other characteristics, such as average size of award, time in effect, and number of awards.

The Research Infrastructure

The research infrastructure consists of three funding mechanisms that support the underpinnings of research. (1) major equipment or facilities support complements research by providing state-of-the-art equipment or instrumentation that is not project specific and/or buildings in which to house research laboratories; (2) training support, specifically designated for fellowships, traineeships, and training grants, provides anticipated human resource needs in areas of research, and (3) institutional support is often funding of a generalized nature that allows the university more discretion in supporting areas of science research not provided for through other forms of support.

By major equipment we mean equipment that is shared by many scientists, is not funded through a specific project, and generally costs more than equipment supported through projects. Although federal agencies do not have an exact dollar range assigned to equipment supported under the research infrastructure, officials at several agencies have suggested dollar amounts beginning in the $200,000 to $250,000 range. An NSF official characterized "major," in part, as items such as telescopes and accelerators. In NIH, as in NSF, there is no policy that clearly distinguishes the kind or cost of equipment supported under the infrastructure of research as opposed to the direct support of research, but an NIH official told us that, as a practical rule, equipment provided under the research infrastructure is targeted for shared use and is not specifically tied to an individual project, program, or center. According to this same official, individual projects involve equipment costing $25,000 or less, while major equipment grants run from $250,000 on up.

By fellowships, we mean awards to individual graduate students in support of their own research as contrasted with research assistantships, which support graduate students on designated research projects. Research assistantships are the major form of training support within the direct support of research, whereas fellowships and training grants are the major form of training support within the support of research infrastructure. Training grants, in contrast to fellowships, are funds to the university, which, in turn, supports students.

This report describes the array of awards and programs that agencies reported within each of the three funding mechanisms of research infrastructure. Appendixes V-VII provide a description of the awards that federal agencies reported under research infrastructure.

Objectives, Scope, and Methodology

In response to the request by the House Committee on Science and Technology, our objective is to provide the following information:

- a description of the past and current array of federal funding mechanisms, including relative magnitudes of support, that the six federal agencies providing most of the funding for university research use;
- a description of the trends over time in the federal agencies' use of funding mechanisms; and
- a description of funding mechanisms used by private foundations and voluntary associations in supporting university research.

In addressing the above objectives we defined current as fiscal year 1984. Further, in addressing current and past mechanisms, we limited ourselves to six federal agencies representing about 90 percent of current fiscal year 1984 total federal support (in actual budget authority) of scientific research performed at universities and colleges. These agencies are: the National Institutes of Health (NIH) within the Department of Health and Human Services; the National Science Foundation (NSF); the Department of Energy (DOE); the Department of Defense (DOD); the National Aeronautics and Space Administration (NASA); and the Department of Agriculture (USDA).

Our data collection for fiscal year 1984 is limited to funds obligated by federal agencies for the performance of research at and by a university department, program, center, or other university facility. This excludes funding of research that is performed by university personnel at government labs or university-affiliated federally funded research and development centers (FFRDCS). DOE, however, specifically pointed out that its funding to universities includes more "indirect" funding than "direct." In fiscal year 1984, DOE obligated $550 million to support the operation of research facilities and scientific instruments that are utilized by university "visiting scientists" to conduct research, as opposed to obligations of $321 million for research performed at universities.

The six federal agencies, as shown in figure 1.2 below, reported to us that in fiscal year 1984 they obligated $4.8 billion for research and development at U.S. universities.[3] NIH and the National Science Foundation (NSF) comprise over three-fourths of this reported total.

[3]DOD's funding in support of research performed at universities is further limited in this study to a portion of its "technology base" called 6.1 funds. DOD reported obligating to universities in fiscal year 1984 $408 million under 6.1 funding, which represents about 80 percent of total DOD obligations to universities for research and development in fiscal year 1984. This total does not include federally funded research and development centers.

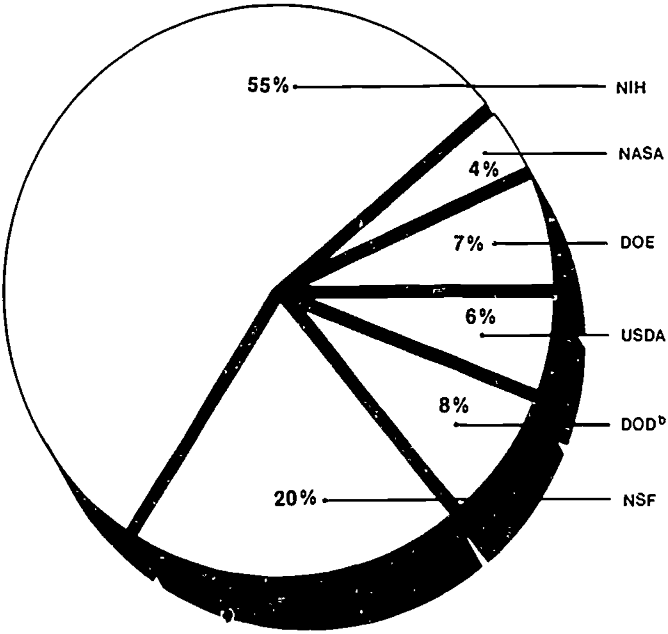

Figure 1.1: Percent of Federal Scientific Research Obligations[a] To Universities/ Colleges by Federal Agency (Fiscal Year 1984)

[a]Limited to obligations of the six federal agencies providing most of the science research funds to universities and colleges. Excludes federally funded research and development centers

[b]Includes only basic or (DOD 6.1) part of DOD's funding of university research

Source: GAO, based on data reported by six agencies

Although the request letter only asked for basic and applied research, the available trend data by funding mechanisms included development. Since the data that the NSF collects shows that over 91 percent of federally sponsored scientific research at universities and colleges can be classified as basic and applied, we believe that including development in our data would not adversely affect the committee's primary interest in data on basic and applied research. Consequently, our reference to scientific research throughout this report except in the case of DOD includes development, as well as basic and applied research.

The request letter also asked for a profile of how both domestic private industries and foreign countries fund research at universities. GAO has previously addressed industry-university research collaboration,[4] and the National Science Foundation sponsored a comparative study of basic research institutions in six countries.[5] Thus, we agreed with the committee to limit our comparison to private U.S. foundations and associations.

In addressing funding mechanisms used by private foundations and voluntary associations, we limited ourselves to four foundations that were among the largest givers to science programs as well as to medical research at universities during 1984. The four foundations are Whitaker, Andrew W. Mellon, Alfred P. Sloan, and Edna McConnell Clark. We selected three voluntary associations based on discussions with the Director of Health Related Research, and the Association of American Universities. The following associations were selected. American Heart Association, American Cancer Society, and American Diabetes Association.

In order to provide a consistent framework for presenting information on the ways the federal government supports university scientific research, we collected data on federal funding mechanisms using six funding categories or mechanisms that can be applied across agencies. In obtaining the six funding mechanisms, we first looked at past studies on federal funding mechanisms and found that, in 1980, the National Commission on Research (NCR) had described in its report on funding mechanisms six types of federal support of scientific research at universities. We also found that both NSF and NIH use federal research funding categories in collecting data for internal use and/or external publication on federal support to universities. On the basis of the various categories of support developed by these federal and nonfederal sources, and after discussions with an advisory panel of outside experts that we convened, we developed the six funding mechanisms described earlier in this chapter.

In addressing trends in federal funding mechanisms, we found that the six federal agencies did not keep trend data on the six funding mechanisms we developed. Consequently, we used the latest trend data collected by NSF and tabulated in its annual publication, Federal Support to Universities, Colleges, and Selected Nonprofit Institutions. NSF began collecting these data in 1966 for the Committee on Academic Science and Engineering. These data, referred hereafter in this report as Federal Support data, tabulate federal funding to universities and colleges from

[4]GAO has issued a report entitled The Federal Role in Fostering University-Industry Cooperation, which examines three forms of university-industry collaboration—research parks, cooperative research centers, and industrial extension services—to develop information and guidelines to help policymakers in designing any new or revised federal initiatives to stimulate cooperation. (GAO/PAD-83-22, May 25, 1983.)

[5]See Performer Organizations and Support Strategies for Fundamental Research United States, France, West Germany, United Kingdom, Japan, and the Soviet Union (SRI International, April 1985), 2 vols.

1963 to 1982 by categories of support. We were able to correlate these categories to the six funding mechanisms we developed. Appendix IX describes the correlation between the definitions NSF uses and our funding mechanisms. The Federal Support trend data include 15 federal agencies, 9 of which were beyond the scope of our study. These additional nine agencies, however, represent less than 10 percent of the estimated support for research and development for fiscal year 1984.

In providing a profile of the current array of federal funding mechanisms, we asked officials from the six federal agencies to provide data on their agency support for university research within the six funding mechanisms we identified. We did not independently verify the data given to us by federal officials, but we did conduct follow-up interviews with knowledgeable agency officials to discuss the data they provided to us.

In collecting data specifically on past federal funding mechanisms that have since been discontinued, we researched archival and agency sources and interviewed agency historians and other knowledgeable officials. In collecting data from foundations and associations we interviewed by telephone knowledgeable officials at four foundations and three voluntary associations and reviewed documents relevant to our study.

Chapter 2

Federal Funding Mechanisms In Support of University Research

This chapter presents a profile of how six federal agencies fund scientific research performed by and at U.S. universities and colleges. Using the six funding mechanisms presented in chapter 1 as a framework, agencies reported a variety of ways they supported scientific research at universities and colleges. Appendix I presents information in full. The first part of this chapter provides an overview of funding mechanisms, while the second half of the chapter discusses specific characteristics of funding mechanisms, namely, how long agencies fund awards, how agencies decide who gets an award, and how two specific cost requirements, cost sharing and indirect costs, affect an award.

Direct Support of Research

Direct support of research describes federal funding of scientific research at universities through research projects. These projects range from individual project support, which funds a discrete research project proposed by an individual researcher, to center support, a mechanism in which research projects are coordinated into a coherent research area with core funding for facilities, equipment, and administrative personnel. The six federal agencies reported that they obligated 89 percent of their total fiscal year 1984 obligations for university research to the direct support of research. A brief discussion of each of the funding mechanisms under the direct support of research follows.

Individual Project Support

Individual project support, as we have defined it, comprises the largest funding mechanism in the federal system of support. All six agencies reported a large percent of their support of scientific research at universities under individual project support. As table 2.1 indicates, the six federal agencies reported for fiscal year 1984 approximately $3.4 billion obligated to universities through this funding mechanism, which is 71 percent of the total federal funding to universities for scientific research during that fiscal year. In general, this funding mechanism encompasses support for scientific research under the direction of a single university researcher who is issued an award competitively for a research proposal. The average dollar size of awards under this mechanism is small compared to dollar sizes of program or center support.

Although we have defined this funding mechanism broadly to include all dollar sizes of research reported by agencies, agencies have provided us with specific variations of individual project support, as table 2.1 indicates. The table shows that individual project support accommodates a wide range of award amounts as well as variations by types of recipient. Appendix II presents a catalogue of types of individual project support as reported by the six agencies.

Agency	Percent of total agency obligations	Total obligations	Number of awards	Average award size
NSF				
Individual Research Project	79	$ 742,000,000	11,082	$ 67,000
Variations	3	32,780,000	427	76,768
1) Research Initiation Grants				
2) Presidential Young Investigators				
NIH				
Individual Research Project	64	1,708,026,629	13,855	123,279
Variations	3	78,450,219	1,789	43,851
3) Small Grant				
4) AREA Grant				
5) New Investigator				
6) Research Career				
DOE*				
Individual Research Project	69	223,211,000	1,463	152,571
DOD*				
Individual Research Project	87	334,285,000	2,848	117,375
NASA*				
Individual Research Project	97	212,996,000	2,433	87,545
USDA*				
Individual Research Project	33	98,450,602	1,493	65,941
Total		$3,430,199,450	35,390	

*Variations not included since they were less than 1 percent

Source: GAO, based on data reported to us by agencies

Table 2.1: Individual Project Support to Universities/Colleges (Fiscal Year 1984)

Types of Individual Project Support

NIH and NSF devoted 3 percent of their funds to variations within individual project support. For example, NIH awards:

- a 1-year small grant for preliminary short-term projects,
- a grant targeted at small colleges in order to make them more competitive for standard NIH awards, and
- a series of career development awards that support new scientists as well as experienced scientists.

Two other agencies, in addition to NIH and NSF, reported other distinct types of individual project support:

- new or young investigator awards aimed at providing initial support for promising young scientists and engineers (DOD, NSF, DOE, NIH);
- research career awards providing stable career positions for established investigators (NIH) (no new awards since 1966);
- distinguished scientists grants to promote wider participation of distinguished scientists in fossil energy research (DOE); and
- research initiation grants in engineering and information science to provide faculty in those fields an opportunity to initiate research (NSF).

All agencies other than NIH and NSF reported either less than 1 percent or none of their total obligations to distinct types of individual project support as described above.

Equipment and personnel needs for a particular research project may be met through individual project support funding. For example, an NSF budget official estimated that about $120 million of NSF funds was provided to universities in fiscal year 1984 for equipment on individual project support, while another $24 million was for equipment supported by larger, more comprehensive research awards, such as centers. The same official told us that NSF individual project support funded over 11,000 research assistantships in fiscal year 1984 as contrasted with 1,460 fellowships.

Program Support

Programs involve the efforts of several principal investigators in research areas larger in scope than those that can be accommodated by individual project support. Five of the six federal agencies reported in fiscal year 1984 about 600 awards worth $419 million under program support. One agency, USDA, did not report any awards under program support. (See table 2.2.) Whereas the average size of awards given by each agency under individual project support ranges from $44,000 to $153,000, program support runs from an average of $89,000 to $1 million among the agencies, as table 2.2 shows. Although program awards are on the average larger than individual project awards, federal agencies, as the table also shows, devote a much smaller portion of their total obligations targeted for university research to programs.

Agency	Percent of total agency obligations	Total obligations	Number of awards	Average award size
NSF				
Research Program	9	$ 80,000,000	78	$1,000,000[a]
NIH				
Program Project	11	285,559,747	449	687,886[a]
DOE				
Research Program	13	42,263,000	55	768,418
DOD				
Joint Services Program	3	10,000,000	13	766,667[a]
NASA				
Program Grant	less than 1	890,000	10	89,000
Total		**$418,712,747**	**605**	

[a]As reported by agency.

Source. GAO, based on data reported to us by federal agencies.

Table 2.2: Program Support to Universities/Colleges (Fiscal Year 1984)

Types of Program Support

With the exception of USDA, all of the agencies reported awards under program support. In some agencies, such as DOD and DOE, program support reflects the use of a research and development contract to fund an interdisciplinary effort or a team of researchers. DOD's Joint Services Electronics Program (JSEP), for example, uses contracts to support groups of investigators performing research across disciplines in electronic sciences. DOE supports a team of researchers in high-energy and nuclear physics through contracts to build customized equipment to which the university holds title, but that is used in DOE labs for a period of time. In NIH the program form of support is often used to more effectively administer those projects that can be related to a larger overall research goal or purpose.

Appendix III presents a list of the types of awards under program support as reported by five of the six agencies.

Center Support

Center support is usually designed to provide "core" funding in the form of research equipment as well as associated research projects. In addition, this core funding can support an administrative unit, called a research center, under the direction of the university that coordinates the performance of a coherent area of research. Seven hundred and thirty awards worth approximately $440 million, ranging in average size from $140,000 to almost $3.4 million were reported by five of the six agencies under center support for fiscal year 1984. USDA did not report any awards under center support. (See table 2.3.)

Agency	Percent of total agency obligations	Total obligations	Number of awards	Average award size
NSF	3	$ 23,650,000	168	$ 140,774
NIH	13	353,160,095	533	662,589
DOE	16	50,816,000	15	3,387,733
DOD	2	7,996,851	6	1,332,809
NASA	2	5,026,000	8	628,250
Total		**$440,648,946**	**730**	

Source GAO, based on data reported to us by federal agencies.

Table 2.3: Center Support to Universities/Colleges (Fiscal Year 1984)

Types of Center Support

In general, center support can serve a variety of objectives, depending upon agency program needs. NIH had the greatest variety of types of center support used for a variety of research areas. For example, NIH funds:

- a center core grant for shared equipment and facilities;
- a specialized center grant providing for both equipment and associated research projects; and
- a comprehensive research center grant that provides support for equipment, associated research projects, and educational transfer activities.

The average award size ranges from $708,000 in the NIH core grant to over 1 million in the comprehensive research center grant.

Center awards from other agencies also carry graduate training support. DOD's research centers not only support groups of investigators, but also increase the number of trained scientists. NASA's Joint University Institutes Grants provide support for groups of investigators performing research across disciplines, as well as enhance research and training capability.

Although we have generally excluded from our study government-owned research facilities near university campuses, DOE reported one center program that provides research support to on-campus research centers in which DOE owns the equipment and may own the building. Each laboratory is staffed by both full-time researchers as well as faculty, and DOE is primarily responsible for full support of research at these centers, although some researchers may receive small research awards from other sources.

Under its on-campus research centers program, DOE obligated $35 million to 13 research centers in 1984. One example is the University of Notre Dame Radiation Laboratory, which was built in 1961-1962, and has been continuously supported by AEC/DOE since then on a special cost-type contract. In 1984 it received $3.1 million.

Appendix IV presents a list of the types of center support reported by five of the six agencies.

The Research Infrastructure

The research infrastructure describes federal funding that is transferred to universities through three distinct funding mechanisms. major equipment and facilities support, special training support through fellowships, traineeships, and training grants, and institutional support. Major equipment and facilities provide state-of-the-art instrumentation or laboratory facilities for performing research, training support provides graduate students the research experience for future human resource needs; and institutional support makes it possible for a university to either maintain or increase its capacity for performing scientific research in ways not provided by other forms of support. In fiscal year 1984 the six federal agencies we reviewed obligated 11 percent of their total funds for university research to the three funding mechanisms under the infrastructure of research.

Major Equipment and Facilities

Major equipment and facilities support has as its objective the purchase and/or renovation of equipment and/or of facilities for use in scientific research. As discussed in chapter 1, federal support for research equipment occurs across the funding mechanisms we have identified for purposes of this report. For example, individual project support allows for equipment needs related to an individual project, whereas equipment provided under major equipment support is generally more costly and is not project specific. An NIH official said the distinguishing feature of a major NIH equipment grant is whether the equipment is shared by scientists as contrasted with being project specific, in which case it is funded through project support. This same official also said that there is a tendency for equipment on individual projects to be worth $25,000 or less, while major equipment grants provide for equipment beginning in the $250,000 range.

Table 2.4 shows that agencies obligated approximately $77 million in major equipment/facilities support in fiscal year 1984 through 805 awards ranging from an average award size of $64,000 to about $565,000. The type of equipment/facilities support reported by agencies in table 2.4 does not include equipment supported through research projects. For example, universities and colleges reported to NSF $335 million in equipment expenditures under fiscal year 1984 federal funds. In addition, an NSF budget official reported to us that almost $180 million was spent by NSF on research equipment in fiscal year 1984 within both project support and major equipment funding. NASA officials report that $22 million, 10 percent of its university research grant money, went to facilities and/or equipment.

Agency	Total funding level	Number of awards	Average award size
USDA			
Agricultural Facilities	not used		
1890 Research Facilities	$ 9,600,000	17	$564,706
DOE			
Research Instrumentation	3,976,000	17	225,000[a]
Used Equipment	N/A	20	N/A
DOD			
Research Instrumentation	30,000,000	237	132,557[a]
NSF			
Specialized Research Equipment	32,900,000	512	64,000[a]
NIH[b]			
Research Facilities	700,000	2	$350,000
Total	**$77,176,000**	**805**	

[a]As reported by agency.

[b]NIH has an instrumentation program that we have listed in table 2.6 under Institutional Support, because eligibility for it is contingent upon receiving institutional funds

Source: GAO, based on data reported to us by federal agencies

Table 2.4: Major Equipment/Facilities Support to Universities/Colleges (Fiscal Year 1984)

Five of the six federal agencies reported some type of major equipment or facilities support that is not research project specific. Examples are

- a construction grant that allows for construction or major remodeling to create new research facilities (NIH);
- specialized facilities and equipment grant to provide equipment/facilities required in very advanced research projects (NSF); and
- graduate research facilities grant to provide buildings and equipment for research at universities (discontinued, NSF).

DOE has identified a unique program for instrumentation called the DOE Used Energy-Related Equipment Program. It makes available to university researchers, through an on-line computer list, equipment or instrumentation no longer needed at DOE's laboratories. For the cost of crating and shipping, a university is given title to surplus equipment.

Appendix VI presents a list of the types of equipment and facilities support reported by five of the six agencies.

Special Training Needs

This category refers to funding in the form of fellowship and training grants. All six agencies reported obligating in fiscal year 1984 almost \$177 million to universities for fellowships and training grants. Under training grants, funds normally go to the university, which in turn, decides the students who will receive support. Conversely, fellowships usually are awarded directly to the individual student from the federal agency. USDA's fellowship program is the only exception among the training programs reported to us. With this program, the award goes to a university to recruit and support a student for 3 years of education.

Types of Training Support

Of the six agencies, NSF and NIH have the greatest variety of fellowships or training grants in fiscal year 1984. NSF awards grants to graduate students, grants for doctoral dissertation research, and postdoctoral research fellowships. NIH awards grants to pre- and postdoctoral students and to experienced scientists, as well as awarding training grants to universities to encourage students in shortage areas. Most of NIH's training awards have statutorily required payback provisions. None can be awarded in areas of the health professions (M.D., D.D.S., etc.). As table 2.5 shows, NSF places most of its emphasis on predoctoral fellowships, while NIH places more emphasis on postdoctoral fellowships.

DOD officials stressed that DOD, as a mission agency, supports fellowships in areas of perceived mission needs.

Agency	Total obligations	Number of awards	Average award size
NIH (NRSA only)			
Predoctoral Fellow	$ 362,388	39	$ 9,292
Postdoctoral Fellowship	21,856,509	1,223	17,871
Senior Fellows	536,479	18	29,804
Training Grant	117,895,885	1,069	113,379[b]
Subtotal	**$140,651,261**		
NSF			
Graduate Fellow	20,300,000	1,460	13,900[b]
Doctoral Dissertation Research	1,190,000	189	6,000[b]
Postdoctoral Research	3,500,000	67	26,100[c]
Subtotal	**$ 24,990,000**		
USDA			
Graduate Fellows (to university)	5,000,000	67	up to 190,000[b]
DOE			
Graduate Fellowship	1,395,000	54	18,000[b]
DOD			
Graduate Fellowship	3,000,000	140	20,000 to 25,000[b]
NASA			
Graduate Student Fellowships	1,800,000	120	15,000
Total	**$176,836,261**	**4446[a]**	

[a]Because training includes both large awards to universities to support more than one student and small awards to support one student, the number of students trained is larger than the total number of awards

[b]As reported by the agencies.

[c]GAO estimate. Agency reported average award size of $152,200 for 2 years

Source. GAO, based on data reported to us by six federal agencies

Table 2.5: Special Training Needs Support to Universities/Colleges
(Fellowships and Training Grants) (Fiscal Year 1984)

Both DOE (formerly AEC) and NSF had traineeships, which have since been discontinued, made to broaden the educational base in science areas.

Appendix V presents a list of the types of training support reported by the six agencies we reviewed.

Institutional support defines federal funding to a university to perform research in some general area or to strengthen its research capability. Two federal agencies, USDA and NIH, currently fund most of the institutional support to universities. In addition, five of the six agencies reported major past programs in institutional support that have since been discontinued.

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Types of Institutional Support

Three of the six federal agencies, USDA, NIH, and NSF, reported almost $270 million in fiscal year 1984 obligations to universities in the form of institutional support.

Agency	Total obligations	Number of awards	Average award size
USDA			
Hatch Act	$144,134,842	57	$2,528,681
Animal Health & Disease	5,496,422	67	82,036
Cooperative Forestry	12,147,700	60	202,462
Evans-Allen	21,866,625	17	1,286,272
Subtotal	**$183,645,589**	**201**	
NIH			
Biomedical Research Support Grant (BRSG)	36,892,858	392	94,114
BRSG-Instrumentation	16,842,000	100	169,970*
Minority BRSG	29,253,264	220	144,414*
Subtotal	**$ 82,988,122**	**712**	
NSF			
Research Improvement at Minority Institutions	2,500,000	10	250,000
Total	**$269,133,711**	**923**	

*As reported by agency.

Source: GAO, based on data reported to us by six federal agencies.

Table 2.6: Institutional Support to Universities/Colleges (Fiscal Year 1984)

As table 2.6 shows, USDA is the largest federal source of institutional funds. Whereas in other agency programs, past or present, institutional funding complements individual research project support, at USDA institutional funding is the basis for its support of scientific research at universities. Sixty-two percent of USDA's obligations for scientific research performed at universities is through their institutional funds program. The Hatch Act Formula Grants, its largest program, account for 48 percent of total obligations.

We are including programs from NIH and NASA in the funding mechanism of institutional support even though they are targeted toward more specific areas within scientific research. NIH's Biomedical Research Grant for Shared Instrumentation is for the purchase of instruments, and could be included under "Equipment and Facilities" support. However, eligibility for this program is based on having received NIH's Biomedical Research Support Grant (BRSG), which is an institutional program based on formula funding. A second program, NASA's Sustaining University Program, since discontinued, included distinct parts dedicated specifically to training, research, and facilities. Because these were parts of an overall package designed to sustain or improve university capacity for doing research, we have included them within institutional support rather than distinct research areas discussed elsewhere in this chapter.

One new institutional type program within DOD has been funded for fiscal year 1986 called the "University Research Initiative." Its objective is to improve the capacity of universities to perform research and encourage the growth of new technologies. A main thrust of this program will be to encourage interaction between industry, academic, and government scientists. (See appendix XII for more detailed information on this program.) Appendix VII presents a list of the types of institutional support reported by three of the six agencies.

Specific Characteristics of the Six Funding Mechanisms

This section focuses on three specific areas in the federal funding of scientific research at universities. These areas are:

- how long an agency provides funding once an award is made or renewed;
- how an agency decides who gets an award; and
- how certain cost requirements, namely indirect costs and cost sharing, are managed.

The first area relates to the continuity and stability of funding. Federal agencies, unless they have special legislative authority, can fund research at universities on a fiscal year basis. Although universities can expect to receive funding for more than one fiscal year (often 3 years), such funding is contingent upon yearly appropriations.

The second area, the award decision process, relates to the selection of new and renewed awards. The processes agencies use in deciding who gets a new or renewed award are particularly important when the competition for awards increases. The third area, cost requirements, relates to how much money is reimbursed to the university for costs of overhead in performing federally funded research (indirect costs) and how much of the costs of the research activities the university has to pay

Duration of Awards

We asked the six agencies to report on award duration within each of the six forms of support. We defined award duration as the average number of years an awardee can expect to initially receive funds given the availability of yearly appropriated funds. After that initial period, an awardee has to compete again for funds to continue his project or to begin a new one.

Award Duration for Direct Support of Research

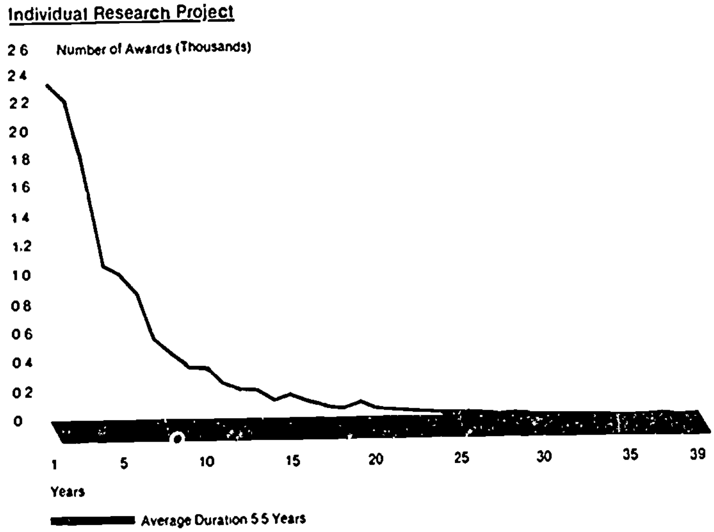
The six agencies reported award durations ranging from 1 to 5 years for all three funding mechanisms. We were not able to find clear distinctions between the reported average award durations of individual projects, programs, and centers. However research center awards generally have longer durations than do individual research projects.

We found that expected award duration is not necessarily an indication of the length of time a project actually lasts. For example, the average expectant duration or "project period" of an award for an NIH individual research project (grant) is 3 years. However, as figure 2.1 shows, the average age of NIH individual projects (grants) as of 1984, is 5.5 years. This indicates that about half of the active awards have been renewed at least once. DOE indicates an average duration of award of 5 years for its on-campus research centers; the Notre Dame Radiation Laboratory, one of those centers, has been continuously supported by AEC/DOE since 1963, as these awards have been renewed at the end of each 5-year period.

Award Duration for Research Infrastructure Support

Special training awards range from 1 to 5 years and tend to last on an average for 3 years. In 1984 USDA, however, began a unique National Needs Fellowship Program featuring 5-year awards. During the 5-year period, the university may use the funds to pay for 1 year of recruiting students into areas of emerging needs in food and agricultural research and to pay for up to 3 years of training within a 4-year period. In this way, the program allows the university to recruit students actively in areas of national needs, and allows a student to take a year off if needed or desired.

Awards for major equipment and facilities are generally made for 1 year and are not renewable because they are for specific purchases. NIH's and USDA's institutional programs are both awarded annually on a formula basis.



Source. GAO. based on NIH data.

Figure 2.1: Length of NIH Individual Research Projects (Grant) (Fiscal Year 1984)

Award Decision Process

With one exception, to be discussed later, the process federal agencies use in deciding who receives funding depends more on the agency that provides the funding than on the types of funding mechanisms used. Table 2.7 shows consistency on the award decision process within each agency rather than within each funding mechanism.

The six federal agencies use two basic review processes that affect the funding of university research. In the first process, peer review, external experts assist agency officials in determining the technical qualifications of a research proposal submitted by a researcher(s). The agencies that use peer review have developed various procedures for involving external scientists in evaluating research proposals.[6] The second process, internal review by agency expert, indicates that internal scientists evaluate the research proposals, although external experts may be consulted on an ad hoc basis. Table 2.7 summarizes agency practice with regard to these two types of award decision processes. NIH and NSF rely primarily on peer review; DOD on internal review by experts; and USDA, DOE, and NASA use both processes.

[6]GAO has reported on the different ways that NSF and NIH have administered "peer review " See Better Accountability Procedures Needed in NSF and NIH Research Grant Systems (PAD-81 29 Sept 30, 1981).

	Individual research project	Research program	Research center	Special training needs	Major facilities and equipment	Institutional
NIH	P	P	P	P	P	Mixed
NSF	P	P	P	P	P	P
DOD						
Navy	I	I	I	I	I	N/A
Army	I	I	I	I	I	N/A
Air Force	I	I	I	I	I	N/A
DOE	P	P	Mixed	P	Mixed	N/A
USDA	Mixed	N/A	N/A	P	Formula	Formula
NASA	Mixed	I	I	I	N/A	N/A

P=Peer review: Scientific experts outside of the agency evaluate proposals.

I=Internal review: Technical experts primarily within the agency evaluate proposals.

Mixed=Both peer review and internal review are used.

Formula=A preestablished formula is used to determine award amount.

N/A=Not applicable. The agency did not report in this category.

Source: GAO, based on data reported to us by six federal agencies.

Table 2.7: Award Decision Process Across Funding Mechanisms

The exception mentioned above refers to the institutional programs at USDA and NIH. All USDA awards and one type of NIH award under institutional support are made on the basis of a predetermined formula that differs by program and factors in specific characteristics considered to be pertinent to the program. USDA has four formula award programs, each with a different formula. Its largest formula award program, the Hatch Act Formula Grants Program, allots funds as follows: 20 percent equally to all agricultural experiment stations; 52 percent on the basis of the ratio of the rural population in the state to the total rural population in all states, and the ratio of farm population in the state to the total farm population in all of the states; 25 percent for cooperative research in which two or more state agricultural experiment stations cooperate; and 3 percent for the Secretary of Agriculture for administration of the act.

NIH's Biomedical Research Support Grant is distributed on a formula basis that uses the previous peer-reviewed research project awards from the Public Health Service (PHS) to determine the actual amount awarded

Indirect Costs

Indirect costs are those costs incurred by the research-performing institution to provide the overall management, the services, the research equipment and facilities (those not originally purchased with federal funds), and the operation and maintenance of facilities required to provide a suitable research environment. Annually, the indirect cost rate for each university performing research for the federal government is determined through negotiations with either DOD or HHS. Reimbursement of indirect costs is determined by multiplying the negotiated indirect cost rate for that university by the university's authorized direct costs for performing federally sponsored research.

Agency policy regarding reimbursement of indirect costs for the most part depends upon the type of funding mechanism as table 2.8 shows

Direct Support of Research

All of the agencies reimburse at the full negotiated indirect cost rate in effect at the time of the award for individual project, program, and center support. USDA's cooperative agreements for individual research projects do not reimburse indirect costs.

	Individual research project	Program project	Research center	Special training needs	Major facilities and equipment	Institutional
NIH	R	R	R	R*	N	Mixed
NSF	R	R	R	N CEA	R**	R
DOD	R	R	R	N CEA	N	N/A
DOE	R	R	R	N.CEA	N	N/A
USDA	Mixed	N/A	N/A	N	N	N
NASA	R	R	R	N CEA	N/A	N/A

R=Reimburse at full negotiated indirect cost rate at the time of the award.

R*=Reimburse at 8 percent of allowable direct cost or through a cost-of-education allowance

R**=Allowed only on installation and maintenance expenses, not on the purchase costs of the equipment

N=No reimbursement

N CEA=No reimbursement, but a cost-of-education allowance is provided.

N/A=Not applicable. The agency had no funds reported in this category.

Mixed=Policy regarding reimbursement of indirect costs varies among the awards

Source GAO, based on data reported to us by six federal agencies

Table 2.8: Indirect Costs Across Funding Mechanisms

Special Training Needs

Typically, training awards do not allow reimbursement of indirect costs. Instead, associated with the award to the student, a cost-of-education allowance is given to the university, which pays for tuition and miscellaneous expenses. NIH may provide for both the reimbursement of indirect costs and a cost-of-education allowance.

Major Equipment

NIH, DOD, DOE, and USDA award funds solely for the purchase of equipment and do not allow reimbursement of indirect costs. According to NIH officials, this procedure is not unusual since equipment purchases are very often excluded from the direct cost base used in the reimbursement of indirect costs. NSF officials informed us that they reimburse the award recipient at the full negotiated indirect cost rate for installation and maintenance costs, not for equipment purchase costs.

Institutional Support

The awards for institutional support are not consistent regarding reimbursement of indirect costs. NSF's awards for improvement of research at minority institutions reimburse the university at the full negotiated indirect cost rate. USDA's awards do not reimburse indirect costs.

Cost Sharing

Cost sharing describes a condition of an award in which the recipient of federal money for the conduct of scientific research contributes to the cost of the authorized research activity. Cost sharing requirements vary by individual federal agency. Several agencies, such · USDA and NASA, have pointed out that cost sharing is a function of st atory requirements rather than funding mechanisms.

Table 2.9 summarizes the cost-sharing requirements of the six agencies NIH requires that award recipients share the cost on all research projects.[7] The rate of cost sharing varies between 3 and 5 percent, and is established by an institutional agreement made between HHS and the university that is on file and applies to all research awards made to that

[7] According to NIH officials, cost-sharing requirements, which have been in effect since 1966, have been deleted from the fiscal year 1986 HHS Appropriations Act.

recipient. In cases where there is no institutional agreement, the cost-sharing requirement is satisfied by a project-by-project agreement between NIH and the university.

NSF has a statutory cost-sharing requirement of 1 percent on all unsolicited research support NSF's interpretation of the cost requirement is that cost-sharing can be averaged over all awards to the institution, with a minimum of 1 percent on each award. Average levels of cost-sharing are much higher. Although NASA is prohibited from fully reimbursing costs for research resulting from unsolicited proposals, on a case-by-case basis it can grant exceptions, and, according to NASA, its use of cost-sharing clauses is minimal.

USDA's individual research grants and contracts generally do not require cost sharing; however, some of its cooperative agreements for research do require the performing universities to share the research costs. Neither DOD nor DOE requires cost sharing.

Training is the only mechanism for which cost-sharing requirements are consistent across the federal government; none of the agencies require cost sharing for training awards.

	Individual research project	Program project	Center	Special training needs	Major facilities and equipment	Institutional
NIH	R 3-5%	R 3-5%	R 3-5%	N	R 50%	Mixed
NSF	R	R	Mixed	N	R 50%	R
DOD	N	N	N	N	N	N/A
DOE	N	N	N	N	N	N/A
USDA	Mixed	N/A	N/A	N	N	Mixed
NASA	Mixed	Mixed	Mixed	Mixed	N/A	N/A

R=Required (when possible the amount of cost sharing required is indicated).

N=Not required.

N/A=Not applicable.

Mixed=Policy regarding cost sharing varies among awards.

Source. GAO, based on data reported to us by six federal agencies.

Table 2.9: Cost Sharing Across Funding Mechanisms

Chapter 3

Trends in Federal Support for University Research

This chapter presents a profile of federal research agencies' use of federal funding mechanisms over time. Because federal agencies did not have trend data on the six funding mechanisms we developed for this report, we relied on data previously collected by NSF showing trends in federal support to universities and colleges from 1963 to 1982. The funding categories used by NSF can be correlated to our six funding mechanisms, but there are two significant differences: trend data collected by NSF does not distinguish among individual project support, program support, and center support; and the category for equipment and facilities is limited to "fixed equipment." In addition, trend data do not address the federal support for equipment or training as part of the allowable costs on research projects. Appendix IX further discusses the similarities and differences between our funding mechanisms categories and those used by NSF.

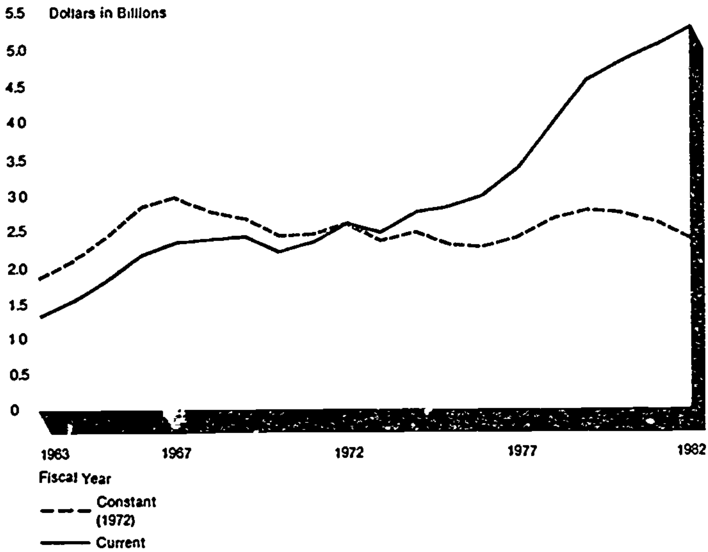
Based on data collected by NSF on federal research and development support to universities and colleges, we found that, between 1963 and 1982, the federal government devoted an increasing percent of its obligations for academic science support at universities to direct support of research and consequently a decreasing percent of those same obligations to the infrastructure of research.

Overall Trends in Scientific Research at Universities and Colleges, 1963-1982

The Committee on Academic Science and Engineering in 1965 established a reporting system managed by NSF to collect data from federal agencies on their support of scientific research performed at universities.[8] This reporting system has data available on up to 15 federal agencies' support of science research at universities since 1963. Although not all of the categories used in this data system have remained consistent since 1963, we have been able to correlate them for certain periods of time with the funding mechanisms used in this report. Using the latest available data from NSF's Federal Support to Universities, Colleges, and Selected Nonprofit Institutions, Fiscal Year 1982[9] and applying deflator values to obtain 1972 constant dollar values, we constructed a number of graphs to show the overall trends from 1963 to 1982 in funding mechanisms to universities and colleges.

[8]This corresponds to the Federal Support category called academic science and engineering research.

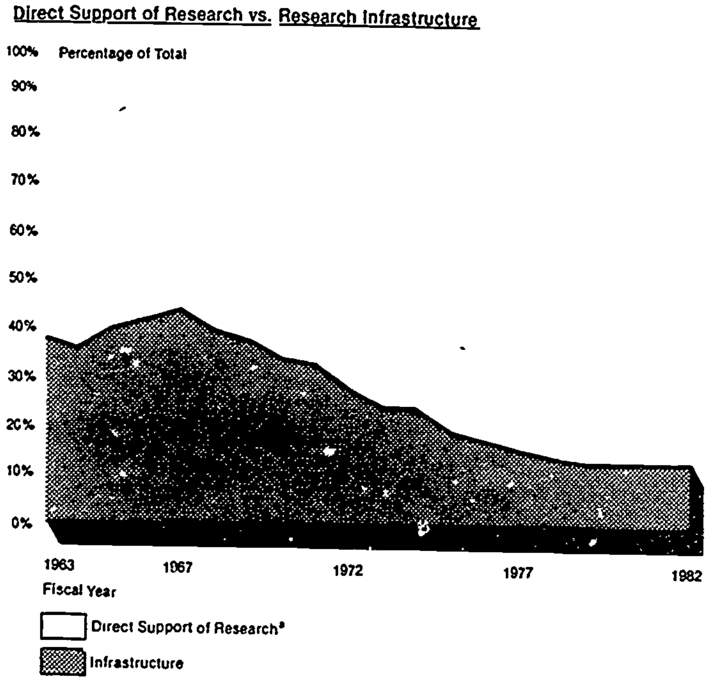
[9]Data used from this publication will be referred to as Federal Support data in this report. Data on 1983 levels of federal support were published by NSF after our data collection was completed.



Source: GAO, based on Federal Support data.

Figure 3.1: Federal Obligations for Scientific Research at Universities/ Colleges (Fiscal Years 1963-1982)

Figure 3.1 snows that, except for a few variations, annual federal support of scientific research at universities and colleges from 1963 to 1982 grew from $1.8 billion in 1963 to $2.5 billion in 1982 in constant 1972 dollars. Moreover, as shown in figure 3.2, direct support for research has taken an increasingly greater percent of the total obligations compared with support for the infrastructure of research, except during the period 1964-1967.



*May include support for equipment as well as graduate assistantships as part of the costs of research projects.

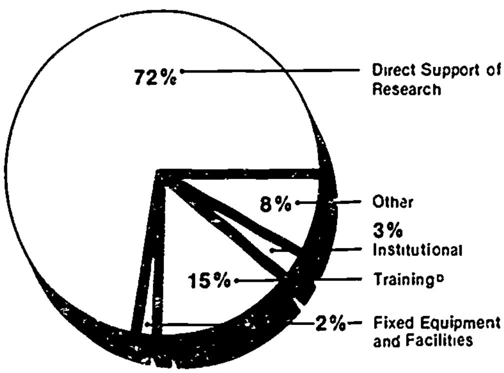
Source. GAO, based on Federal Support data

Figure 3.2: Percent of Federal Scientific Research Obligations to Universities/ Colleges by Funding Category (Fiscal Years 1963-1982)

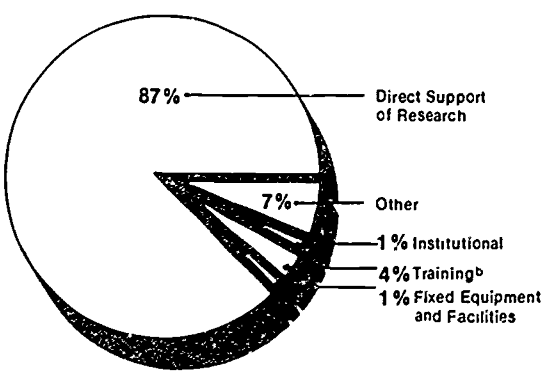
Figure 3.3 shows that direct support of scientific research at universities has grown from 62 percent of total federal obligations in fiscal year 1963 to 87 percent of total obligations in fiscal year 1982. Conversely, funds exclusively designated for fixed equipment and facilities have declined from 8 percent to 1 percent over the same time period. In addition, funds designated for fellowships, traineeships, and training grants support have declined from 17 percent in 1966 to 4 percent in 1982; and institutional support has declined from 4 percent to 1 percent of total obligations from 1971 to 1982.

Federal Support trend data includes an additional category called "other" that, until 1966, included training, and until 1971, included general institutional support. Since 1971, "other" has been a separate category that includes types of activities, such as technical conferences, teacher institutes, and activities aimed at increasing the scientific knowledge of pre-college and undergraduate students. In 1963, when this category included fellowships, traineeships, training grants, and general support, it received 30 percent of total federal obligations. In 1982, it received 7 percent. Although we do not address the activities under the "other" category in our funding mechanism study, we include it in our trend data since it included, for certain periods, both training and institutional support (see figure 3.3).

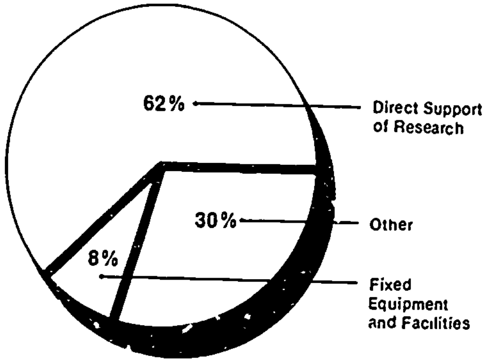
FY 1972



FY 1982



FY 1963



[a] In constant 1972 dollars.

[b] Funds for fellowships, traineeships, and training grants.

Source: GAO, based on Federal Support data

Figure 3.3: Percent of Federal Scientific Research Obligations[a] To Universities/Colleges by Funding Mechanism (Fiscal Years 1963, 1972, and 1982)

Trends in Direct Support Research

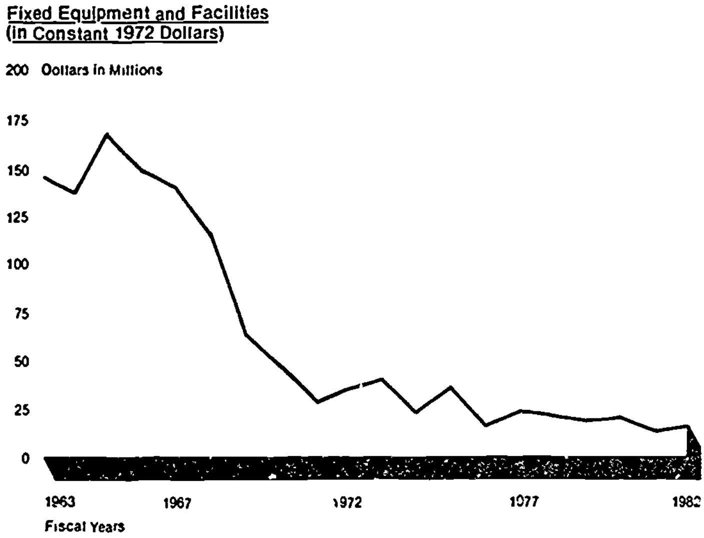
From 1963 to 1982, federal direct support of research increased in constant 1972 dollars from $1.1 billion of $1.8 billion in total federal support in 1963 to $2.2 billion of $2.5 billion in total federal support in 1982. Thus, an increasing amount was available for research projects over this 19-year period not only in absolute dollars, but also as a percentage of the total obligated funding. As noted in chapter II, the direct support of research allows for equipment and research assistantships tied to a specific research project or set of projects.

Trends in the Scientific Research Infrastructure

From 1963 to 1982, federal support for the research infrastructure declined in constant 1972 dollars from $688 million out of $1.8 billion in total federal support in 1963 to $331 million of $2.5 billion in total federal support in 1982. While federal funding for the research infrastructure took 38 percent of total funding for science research in 1963, it took 13 percent in 1982. This section discusses three funding mechanisms that comprise the research infrastructure.

Fixed Equipment and Facilities

This section includes funding targeted specifically at fixed equipment for use in research, as well as construction of facilities for research. As figure 3.3 shows, support under this funding category has declined overall from about 8 percent of total science research funding in 1963, when the federal government obligated (in constant 1972 dollars) $146 million of $1.8 billion, to 1 percent in 1982 when it obligated $15 million of $2.5 billion. Figure 3.4 shows an increase in federal obligations to fixed equipment and facilities between 1963 and 1965 and then a steady decline after 1965.



Source: GAO, based on Federal Support data

Figure 3.4: Federal Obligations for the Scientific Research Infrastructure at Universities/Colleges (Fiscal Years 1963-1982)

The termination of major federal facilities programs accounts for the steady decline in federal obligations for fixed equipment and facilities. The two largest programs were the NSF Graduate Resea[illegible] [illegible]ilities Program (1960-1970) and the NIH Health Research Faci[illegible] Program (1957-1972). According to the analysis in the Federal Support survey, much of the 1969 to 1970 decline in this funding category may be attributed to a shift in government policy away from direct federal support of facilities toward other mechanisms, such as subsidizing interest payments on loans financed through nongovernment sources. Decreasing levels of support from NSF and NIH account for 80 percent of the drop between 1967 and 1970.

In addition to the major programs at NIH and NSF were smaller facilities programs run by other federal agencies. NASA's Sustaining Universities Program (1962-1971) had a distinct element devoted to facilities construction that contributed approximately $43 million to this funding mechanism. The Atomic Energy Commission (AEC), which is now a part of DOE, also contributed to facilities construction through its program to establish accelerators at universities, and through assistance on an ad hoc basis for construction of specialized energy research facilities. It is not possible to determine how much money AEC contributed through these mechanisms. Federal Support data indicate that, between 1963 and 1969, AEC obligated $55 million to the funding mechanism of fixed equipment and facilities. Both the NASA and the AEC programs are discussed in greater detail in appendix I.

Trends in Training Support/ Fellowships, Traineeships, and Training Grants

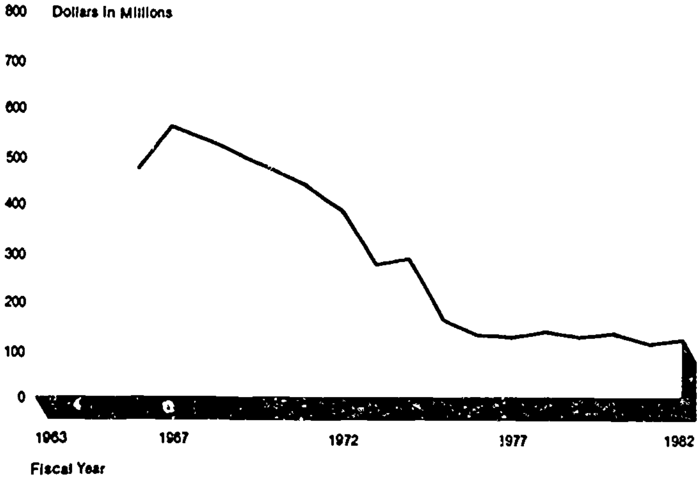
In fiscal year 1966, when Federal Support data on training as a separate research category were first available, the federal government devoted 17 percent ($476 million out of $2.8 billion, in constant 1972 dollars) of its total funding of science research performed at universities to fellowships, traineeships, and training grants. By 1982 this level had dropped to 4 percent ($112 million out of $2.5 billion) of the total. Figure 3.5 demonstrates a steady decline since the late 1960's in federal obligations to these special training awards. According to the Federal Support analysis, this decline resulted from a shift in the early 1970's in federal policy, especially within NIH and NSF, from direct support of graduate students through fellowships and traineeships to indirect support of graduate students as research assistants on research projects. According to NSF data, almost twice as much federally sponsored training to universities occurred in fiscal year 1982 through research assistantships on research projects than through fellowships and traineeships.

Three of the six federal agencies had discontinued or de-emphasized their special training programs by the early 1970's. NASA, NSF, and DOE have discontinued or de-emphasized their agency-wide training grant and fellowship programs. NASA's Sustaining Universities Program had as its largest component a training grants program that provided $105 million before it ended in 1971. NSF shifted its science education program toward improvement of educational curricula and away from direct support of students in 1971, and ended its traineeships in 1973, although it continued its fellowship program. DOE ended its fellowship program in 1973[10] and its traineeship program in 1982. The combined value of DOE's training programs over their lifetime was $30 million.

[10]DOE informed us that while it has ended its agency-wide, generic graduate research fellowship program, individual DOE technology programs can support graduate fellowships where future human resource shortages of advanced degree professionals are identified.

NIH currently has the largest fellowship and traineeship program. According to a knowledgeable agency official, the form of NIH's program has not changed much since the 1950's. The one change has been that, in

Fellowships, Traineeships, and Training Grants (In Constant 1972 Dollars)



Source: GAO, based on Federal Support data.

Figure 3.5: Federal Obligations for the Scientific Research Infrastructure at Universities/Colleges (Fiscal Years 1966-1982)

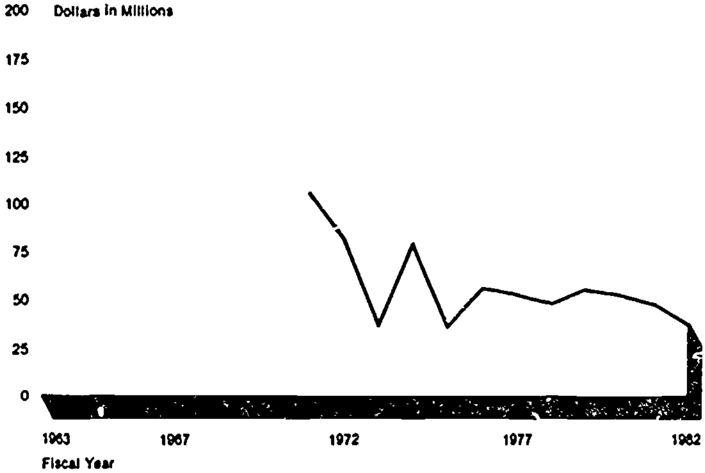
1974, with the passage of the National Research Services Awards (NRSA) authorization, NIH's fellowships and traineeships were formed to include payback provisions and to exclude recipients pursuing health professional degrees. Another agency official indicated that these restrictions led NIH to enhance a series of career development individual research project awards. These awards allow NIH to support young investigators beginning their careers, and experienced investigators wishing to develop new research expertise, without the payback restrictions of the training awards. The career development awards at NIH are in addition to their fellowship and traineeship awards.

The bulk of federal training awards are to students pursuing graduate degrees or to postdoctorates within a few years of having received a Ph.D. NSF offered two training programs of a different type, now discontinued, for senior investigators, namely, a senior Postdoctoral Fellowship and Senior Foreign Scientist Fellowship Program.

Trends in Institutional Support

This section corresponds to the Federal Support category of general support, which includes funding mechanisms for nonspecific or generalized purposes related to scientific research at universities. As figure 3.6 shows, no trend data is available on the category "general support' before 1971. Before this time, it was part of another category called "other S/E activities" (other science/engineering activities). In 1971, the federal government reported \$105 million (in constant 1972 dollars), or 4 percent of total obligations for science research in institutional support, and by 1982, funding in this category had dropped to \$38 million, or 2 percent of the total. The figure shows that institutional support declined after 1971 except for a brief period from 1973 to 1974.

Institutional Support
(In Constant 1972 Dollars)



Source: GAO, based on Federal Support data.

Figure 3.6: Federal Obligations for the Scientific Research Infrastructure at Universities/Colleges (Fiscal Years 1971-1982)

We found five programs of a broad institutional nature clustered in the 1960's, all of which were discontinued by the early 1970's. These programs were: NSF's Institutional Grants for Science, NASA's Sustaining University Program, NSF's Science Development Program, NIH's Health Science Advancement Award Program, and DOD's Project Themis. We also found two smaller, more focused institutional programs developed a decade later. A brief discussion of each of these seven programs follows.

Discontinued Institutional Programs

Although NIH's Biomedical Research Support Grant is the only program of its type in existence at this time, NSF's Institutional Grants for Science (1961-1974), like the current NIH Biomedical Research Support Program, were formula awards based on past awards, and, like the NIH program, were meant to maintain university research capacity.

In addition to NSF's formula program, four major discontinued programs were created either to create research expertise that did not exist or to increase expertise beyond what did exist. Unlike the formula program, funding for these programs was based on a plan submitted to the agencies outlining their proposed development. NASA's Sustaining University Program (1964-1971) was created to develop a national aerospace research and training capability where none existed before. NSF's Science Development Program (1964-1972) and NIH's Health Sciences Advancement Award Program (1966-1974) were also created about the same time. These programs, which have also been termed "centers of excellence" programs, set a precedent in federal funding of university research because, unlike previous awards made on the basis of demonstrated excellence, they were awarded largely on the basis of potential to develop research excellence. Both of these programs appear to have been the institutional response to the 1960 Seaborg report, Scientific Progress, the Universities, and the Federal Government, produced by a panel of the President's Science Advisory Committee calling for a doubling of the nation's centers of excellence. A fourth program, DOD's Project Themis (1967-1971) was designed to support research programs at universities not heavily engaged in research for the federal government.

Two smaller, more focused institutional programs were developed a decade later. DOE's University Institutional Research Grants Program (1976-1982) was designed to develop both research capability and manpower in energy research. A DOE evaluation of this program showed that every dollar of the institutional award drew 5 dollars of additional support for follow-on research from DOE or other sources. In addition, NIH's Biomedical Research Development Grant (1977-1983) assisted universities that were not capable of qualifying for the ongoing Biomedical Research Support Grant.

Agency Comments and GAO's Response

The agencies generally commented that they felt the report was informative and useful. Five of the six agencies specifically commented that they support the research infrastructure through all six funding mechanisms in that research projects generally provide for some equipment purchases and graduate research assistantships on these projects. We have noted and emphasized this point throughout the text where appropriate.

All six agencies suggested technical and editorial changes to the report. Where appropriate, we have incorporated these suggested changes into the report text.

Chapter 4

Funding Mechanisms Used by Seven Nonprofit Foundations and Associations

For purposes of comparison with the federal system of support for university scientific research, the House Committee asked us to collect information on the funding mechanisms used by private foundations and voluntary associations in support of university scientific research. We chose the seven largest reported givers to science research at universities among U.S. foundations and voluntary associations for fiscal year 1984 and collected data on their systems of funding based on telephone interviews and publically available documents. We did not find any new or distinct mechanisms used by the foundations and associations that were not already used by the federal government.

The foundations and associations we reviewed were. the Alfred P. Sloan Foundation, the Whitaker Foundation, the Andrew Mellon Foundation, the Edna McConnel Clark Foundation, the American Cancer Society, the American Heart Association, and the American Diabetes Association.

The seven nonprofit foundations and voluntary associations provided $75 million to universities in 1984 in support of scientific research. These funds were in the form of individual research projects, support to fund research centers, fellowship awards, and support to build facilities. For each of the funding mechanisms identified by the foundations and associations, we found an equivalent in the current federal system of funding mechanisms. The foundations and associations we contacted did not identify two mechanisms that were identified by the six federal agencies, namely program project support and general institutional support.

Table 4.1 shows the relative magnitudes of support for 1984 that each of the seven U.S. foundations and associations gave to science research at universities and colleges.

Individual Project Support

Like the federal system, foundations and associations give most of their funds through individual project support. Eighty-six percent of these organizations' dollars was through this mechanism, as opposed to 71 percent for the federal government. As tables 4.2 through 4.4 show, 16 types of individual research awards were identified across the founda-

Foundation	Total funds reported 1984	Percent of total	Award decision	Cost sharing
American Cancer Society	$52,585,300	70	Peer review	Not required
Alfred P Sloan Foundation	4,071,850	5	Peer review	Not required
Andrew Mellon Foundation	6,200,000	8	Peer review and internal review	* Not required
Whitaker Foundation	2,977,000	4	Peer review and internal review	Not required
American Heart Association	6,374,000	8	Peer review	Not required
American Diabetes Association	100,000	less than 1	Peer review	Not required
Edna McConnell Clark Foundation	2,9[illegible],000	4	Peer review and internal review	Not required
Total	$75,208,150	100		
FUNDING MECHANISM				
Individual project support	[illegible],776,350	86		
Center support	5,500,000	7		
Special training needs	4,054,800	6		
Major equipment and facilities	877,000	1		
Total	$75,208,150	100		

Source: GAO, based on data reported by seven foundations and associations

Table 4.1: Seven U.S. Foundations' And Associations' Funding of Science Research at Universities and Colleges (1984)

tions and associations we reviewed, and among these, 10 were targeted to specific recipients, 6 to new investigators (refer to table 4.3), and 4 to experienced investigators (refer to table 4.4). The six remaining awards (table 4.2) were not targeted to a specific type of recipient. These six types of awards accounted for 84 percent of the total funds reported by these seven U.S. foundations and associations.

Sponsor	Type of award	Total size—1984	Average size
American Cancer Society	Research & Clinical Investigator (2-year award. Pays for indirect costs up to 25 percent of direct costs)	$47,130,000	$107,602 (2 years)
Alfred P. Sloan Foundation	Individual Research Project (May also be used for meetings, seminars, workshops under $30,000. Does not pay indirect costs. 1-year award.)	151,850	21,700
Edna McConnell Clark Foundation	Traditional Research Project (Foundation uses a strategic plan to direct research programs. Pays up to 12 percent of direct costs for indirect costs. 2-year award.)	2,900,000	50,000 - 75,000[a]
Andrew Mellon Foundation	Single Project Grants (May actually fund a single investigator or group of investigators Does not pay salary of researcher or indirect costs. 3-year award.)	1,800,000	200,000 (3 years)
American Diabetes Assoc.	Feasibility Grants (Seed money for new ideas to develop preliminary data in order to qualify for another source of funds, such as NIH Does not pay salary of researcher or indirect costs. 2-year award.)	75,000	25,000
American Heart Assoc.	Research Grants in Aid (Pays indirect costs up to 10 percent of direct costs. 1- to 3-year award.)	3,200,000	32,000

[a]As reported to GAO.

Source: GAO, based on data reported by seven foundations and associations

Table 4.2: Seven U.S. Foundations' And Associations' Funding of Individual Project Support (1984)

Sponsor	Type of award	Total size—1984	Average size
American Cancer Society	Institutional Research Grants (Granted to university to choose recipients. Allows a new investigator to develop research expertise in order to be able to compete in regular research awards. Pays for indirect costs up to 25 percent of total direct costs. 1-2 year award.)	$2,300,000	$20,000 - 70 000ᵃ
American Cancer Society	Junior Faculty Research Awards (For recent postdoctoral students. Does not pay indirect costs 3-year award.)	1,100,000	20,000
American Diabetes Assoc.	Research & Development Award (2-year award.)	25,000	25,000
Whitaker Foundation	New Investigator Research Award (1 or 2 principle investigators within 10 years of receipt of Ph D. Pays indirect costs up to 20 percent of direct costs 1- to 3-year award.)	2,100,000	50,000
Andrew Mellon Foundation	Research Career Awards (Granted to university to choose recipients. Awardees are new investigators who need to develop a research record. Last award in 1982 Does not pay indirect costs. 3-year award.)	0	225,000 - 500,000ᵃ (3 years)
American Heart Assoc.	Established Investigators Award (To assist young physicians and scientists to develop research careers. Does not pay indirect costs. 5-year award.)	$2,300,000	34,000

ᵃAs reported to GAO.

Source GAO. based on data reported by seven foundations and associations

Table 4.3: Seven U.S. Foundations' And Associations' Funding of Individual Project Support (1984)(New Investigators)

Duration

Most of the types of awards reported under individual project support varied in duration from 1 to 3 years. Seven, almost half, of the awards were for 1 to 2 years, two were for 1 to 3 years, and three were for 3 years. There were four exceptions. a new investigator research award from the American Heart Association for 5 years; two experienced investigator research awards from the American Heart Association and the American Cancer Society, and a research career award sponsored by the Andrew Mellon Foundation for which no new awards have been given since 1982.

Sponsor	Type of award	Total size—1984	Average size
American Cancer Society Award	Research Professorships (Award to an excellent scientist. 25 active at any time. About 25 percent of recipients are nobel laureats. Does not pay indirect costs. 5-year award)	Not available	$40,000
American Cancer Society Award	Scholar Grants (To allow an established investigator to go to another institution for short-term study. Pays an institutional allowance of $2,000. 2-year award.)	$149,300	35,000
American Heart Association	Career Investigatorships (No new awards since 1959. Includes salary, department allowance, and project grant, but does not pay indirect costs. Lifetime award.)	1984: Not available	Not available
American Cancer Society	Faculty Research Awards (Salary support to relieve faculty of clinical or teaching duties to allow them to do research. Pays institutional allowance of $1,000. 5-year award.)	1,545,200	$30,000

Source: GAO, based on data reported by seven foundations and associations

Table 4.4: Seven U.S. Foundations' And Associations' Funding of Individual Project Support (1984)(Experienced Investigators)

Award Review, Cost Sharing, and Indirect Costs

All of the foundations and associations use either peer review or a combination of peer review and internal review in deciding award recipients None of the seven institutions explicitly require cost sharing on their awards. However, some awards may require the universities to pay the salaries of researchers and the indirect costs of research, and therefore, implicitly require cost sharing. Regarding reimbursement to universities for the indirect costs of performing research, the foundations and associations varied in their policies, from not paying indirect costs, to paying up to 25 percent of the direct cost rate to cover indirect costs, to providing an allowance to the university to cover indirect costs.

Program Support

The foundations and associations did not identify any mechanisms similar to the program project type of mechanism used by the federal agencies.

Sponsor	Type of award	Total size—1984	Average size
Research Facilities			
Whitaker Foundation	Research Facilities Construction (For research facilities at universities where Mr. Whitaker was involved. No new awards in 1984. Annual supplements made to previous awards. Does not pay indirect costs.)	$ 877,000	Not available
Research Centers			
Andrew Mellon Foundation	Center Grant (To provide training and research opportunities for young researchers in clinical epidemiology. Does not pay indirect costs. 3-year awards.)	4,400,000	$ 628,000
Alfred P. Sloan Foundation	Multidisciplinary Centers (Seed money to establish a research center of multiple disciplines for a long-term program of training and research in cognitive sciences. Able to generate own sources of funds after foundation support ends. Pay up to 15 percent of direct costs to cover indirect costs. 3- to 5-year award.)	1,100,000	3 types. 500,000/3 years 1,000,000/5 years 2,500,000/5 years

Source. GAO, based on data reported by seven foundations and associations

Table 4.5: Seven U.S. Foundations' And Associations' Funding of Research Centers and Facilities (1984)

Center Support

As table 4.5 shows, the foundations and associations identified two programs for the purpose of establishing centers. The Andrew Mellon Foundation center grant establishes a center to provide training and research opportunities for young researchers in clinical epidemiology. The Alfred P. Sloan Foundation's Multidisciplinary Centers Program provides seed money to establish multidisciplinary research centers in the cognitive sciences.

Duration, Award Review, Cost Sharing, and Indirect Costs

The Sloan Foundation's center awards, made for 3-5 years, are granted on the basis of peer review. They do not require cost sharing and pay up to 15 percent of the direct costs to cover indirect costs. The Mellon Foundation's center awards, made for 5 years, do not require cost sharing and do not reimburse indirect costs.

Special Training Needs

As table 4.6 shows, the foundations and associations identified seven types of awards in support of special training needs. Three of these are directed at encouraging medical doctors, medical students, or clinicians to do research: specifically, the American Cancer Society's physician research training fellowships, and the American Heart Association's medical student research and clinician scientist research awards. The American Diabetes Association offers a 1-year predoctoral fellowship, and the Sloan Foundation offers a dissertation fellowship in math and economics as well as a research fellowship. Additionally, the American Cancer Society has a postdoctoral fellowship.

Sponsor	Type of award	Total size—1984	Average size
American Cancer Society	Postdoctoral Fellowships (For young investigators to develop an independent research career. Pays an institutional allowance of $1,000. 1-year award.)	$ 112,500	$15,000
American Diabetes Assoc.	Fellowships (Does not pay indirect costs. 1 year of support.)	0	15,000
Alfred P. Sloan Foundation	Research Fellowships (To stimulate research in specified areas. May allow up to 15 percent of award for an institutional allowance, but in 1984, not allowed. May be used for equipment, summer support, travel, or other purposes approved by university.)	2,300,000	25,000
Alfred P. Sloan Foundation	Dissertation Fellowships (Limited to math and economics as they feel there are other available sources of funds for laboratory scientists. Does not pay indirect costs, but does pay tuition. 1-year award.)	520,000	8,000 + tuition
American Cancer Society	Physician's Research Training Fellowships (To get more M.D.s involved in cancer research. Includes an institutional allowance of $1,000. 1- to 2-year award.)	248,300	15,000
American Heart Association	Medical Student Research Fellowship (To encourage medical students to do research. Indirect costs are not reimbursed, but $1,500 is paid to institution for training expenses. 3-year award.)	$285,000	$ 9,500
American Heart Association	Clinician Scientist Awards (To encourage talented young physicians to undertake career in clinical investigation. Does not pay indirect costs. 5-year award.)	589,000	42,000

Source: GAO, based on data from seven foundations and associations.

Table 4.6: Seven U.S. Foundations' And Associations' Funding of Special Training Needs (1984)

Foundations and associations identified two training programs as having been developed because not enough money was available from other sources in the specified area: the Sloan Foundation offers dissertation fellowships specifically in math and economics, and the American Cancer society offers postdoctoral fellowships in cancer research.

Duration, Award Review, Cost Sharing, Indirect Costs

Five of the types of training awards were funded for 1 to 2 years, one for 3 years, and one for 5 years. All of these awards were made on the basis of peer review, and none required cost sharing. Indirect costs for training mechanisms often take the form of a cost-of-education allowance to an institution to pay for tuition and other miscellaneous expenses. The policies of the foundations and associations regarding paying the university indirect costs in addition to the direct award to the student vary from not allowing an institutional cost-of-education allowance to designating an amount to the institution.

Major Equipment and Facilities

As table 4.5 shows, the Whitaker Foundation identified one program to provide research facilities at universities where Mr. Whitaker was involved. No specific programs to provide for renovation or purchase of major equipment were identified.

Duration, Award Decision, Cost Sharing, Indirect Costs

The research facilities construction grants from the Whitaker Foundation are provided on an ad hoc basis. Awards are granted on the basis of internal review; they do not require cost sharing, and they do not pay indirect costs.

Institutional Support

No foundation or association programs were identified that corresponded to the institutional category used in this study.

Summary

In summary, the foundations and associations make research awards to universities through mechanisms similar to those used by the federal government. The private foundations and voluntary associations that provided data did not report any funding mechanisms that are not already in use by the federal government. Conversely, we found that they do not make awards through some of the mechanisms used by the federal government, namely, program support and general institutional support. The seven foundations and associations place a greater reliance on the direct support of research (93 percent) than does the federal government (89 percent), but less on the infrastructure of research (7 percent) than does the federal government (11 percent).

The foundations and associations, like the federal government, rely more on peer review than internal review for award decisions. They do not have cost-sharing requirements, whereas this requirement varies among federal agencies. Policies regarding reimbursement of indirect costs at the foundations and associations vary from not reimbursing indirect costs to reimbursing up to 25 percent of the direct costs to cover indirect costs. The federal agencies, on the other hand, have a more consistent policy for reimbursing indirect costs within some of the funding mechanisms.

Appendix I

Data Elements of Federal Funding Mechanisms

Appendixes II-VII present a catalogue of the funding mechanisms used by six federal agencies to fund scientific research at universities. Six categories of funding mechanisms form the divisions within the catalogue: individual project support, program support. center support, training, equipment and facilities, and institutional support. Please see figure 1.1 in chapter I for definitions of these six mechanisms.

The six categories of mechanisms apply across all six agencies, which makes it possible to organize this catalogue by funding mechanism rather than by agency. However the catalogue shows many variations within these six categories as reported by the individual agencies.

Each funding mechanism will be described in the following format.

Agency and Award Title

Primary Objective: A brief description of the purpose to be achieved by the funding mechanism.

Time in Effect: The year when the mechanism first came into effect. when applicable, the year the mechanism was discontinued. Present means that the mechanism was in effect during fiscal year 1984.

How Large an Effort: For current mechanisms, the following is provided only for fiscal year 1984. If agency distinguished between grant, cooperative agreement, and contract, we indicate such distinction.

- Total Funding Level: Total fiscal year 1984 obligations.
- Number of Awards: The number of awards made in fiscal year 1984.
- Average Award Size. As reported by agency. If not reported by agency, the total funding level is divided by the number of awards.
- Average Duration of Award. The amount of time contingent on yearly appropriations that an award is intended to cover without having to be competitively renewed. For example, a 3-year award is intended to provide 3 years of support for a research project. At the end of 3 years, the researcher(s) must apply competitively for a new award.

Award Decision Process: One of two types will be identified. peer review, in which scientific experts from outside the agency assist in deciding who will receive an award. In this case, each agency has established its own procedure for peer review. The second type is internal review, in which experts within the agency decide who will receive an award. In some cases, agencies who use internal review, will, on an ad hoc basis, consult external experts before making a decision, but this is not a formal process.

Cost Sharing: Indicates whether the funding mechanism requires that the research-performing organization share in the cost of research. This varies by agency, and some agencies have statutory requirements for cost sharing.

Indirect Costs: Indicates whether the agency reimburses the research-performing organization for the costs associated with maintaining the capability to perform research; for example, maintenance of facilities, utilities, or administrative salaries.

Other Significant Characteristics: This section was included if, in our view, additional available information was significant.

For discontinued programs the format may include the following categories:

How Large an Effort. Includes the total obligations over the life of the program, if available. Alternatively, information is provided on the total number of awards made during the lifetime of the program.

Award: This is highly variable due to the differing availability of data for the discontinued programs. All award information we gathered on average size of award, duration of award, decision process, cost sharing, and indirect costs is included in this section.

Reason for Implementation. When it was possible to isolate specific reasons, this section is used to indicate special or unique reasons for implementing the specific program.

Reason for Termination When it was possible to isolate specific reasons, this section indicates why the program was terminated.

Evaluations. As applicable. This section identifies evaluations that have been performed on the specific program.

Appendix II

Individual Project Support

NIH
Individual Research Project

Primary Objective: To support a discrete, specified research project to be performed by a named investigator(s) in an area representing his/her specific interest and competence.

Time in Effect: 1961 to present.

	Fiscal Year 1984			
	Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
Grants (92%)	$1,566,102,018	13,152	$121,947	3 years
Contracts (6%)	95,634,011	396	241,500	*
Cooperative agreements (3%)	46,290,600	307	165,944	*
Total	$1,708,026,629	13,855		*

*Not available.

Award Decision Process: Peer review (for grants and cooperative agreements).

Cost Sharing: 3-5 percent.

Indirect Costs. Reimburse at full negotiated indirect cost rate except for selected contracts.

Other Significant Characteristics The grant is the primary instrument of choice for NIH. Cooperative agreements are used selectively, the major user is the National Cancer Institute for testing cancer drugs. Contracts and grants are used for clinical trials.

More than 50 percent of NIH's funds to universities for research are awarded through this mechanism.

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NSF
Individual Research Project (Grant)

Primary Objective: This award is to support an individual investigator performing research.

Time in Effect: Early 1950's to present.

Fiscal Year 1984			
Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$742,000,000	11,082	$67,000	2-3 years

Award Decision Process: Peer review.

Cost Sharing: Statutory cost sharing averaged over institution with 1-percent minimum on each award.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

Other Significant Characteristics: This is the basic mechanism for most of NSF's programs. According to an NSF official, it is a flexible mechanism, allowing NSF to adjust to a wide range of circumstances.

The principal change in this mechanism in recent years has been the delegation of much administrative decision making to the institutions, thus reducing the paperwork burden on universities and NSF, and increasing flexibility.

A subcategory within this mechanism is directed specifically at minority researchers; the other characteristics are similar.

NASA
Individual Basic Research Project

Primary Objective: Support of an individual investigator performing long-range basic research.

Time in Effect: 1959 to present.

	Fiscal Year 1984			
	Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
Grants	$113,986,000	1,674	$68 000	*
Contracts	82,799,000	428	193,000	*
Cooperative agreements	16,211,000	331	49,000	*
Total	$212,996,000	2,433		*

*Not available.

Award Decision Process. Awards made in the space sciences area are peer reviewed, awards made in the air and space vehicles technologies areas are reviewed by NASA technical experts.

Cost Sharing. According to NASA, use of cost-sharing clauses in university research awards is minimal.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

Other Significant Characteristics. About two-thirds of NASA's individual research projects are funded through grants. The individual basic research project makes up 96 percent of NASA's support for research performed at universities.

DOD
Individual Research Project

Primary Objective: Funding for an individual investigator performing research in support of the national security mission of DOD.

Time in Effect: 1946 to present.

	Fiscal Year 1984			
	Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
Grants	*	595	$92,000	*
Contracts	*	2,253	124,000	*
Total	$334,265,000	2,848		3 years

*Not available.

Award Decision Process: Internal review.

Cost Sharing: Encouraged, but not required.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

DOE
Individual Research Project

Primary Objective: Support of an individual performing research in a field of programmatic interest to DOE.

Time in Effect: Late 1950's (AEC) to present (DOE).

	Fiscal Year 1984			
	Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
Grants	*	422	$86,000	*
Contracts	*	1,041	179,000	*
Total	$223,211,000	1,463		2 years

*Not available

Award Decision Process: Most are peer reviewed.

Cost Sharing: Not required.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

Other Significant Characteristics. According to a knowledgeable agency official, grants tend to be used by newer offices within DOE. These often are offices transferred from agencies where grants were used (for example, solar research, which came from NSF, uses grants). The older offices use the special research contract, which had its beginnings in AEC. In 1985, however, most research projects will be issued as grants.

About 77 percent of DOE's direct funding for university research is through this mechanism.

USDA Special Research Grants

Primary Objective: Support of an individual performing research on problems of national interest beyond the emphasis of the formula programs.

Time in Effect: 1966 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$25,462,624	306	$83,211	1-5 years

Award Decision Process: Some are awarded at congressional discretion, and some are awarded through competitive peer-review panel.

Cost Sharing: No requirement.

Indirect Costs: Some grants allow for reimbursement of indirect costs, and some do not.

USDA Competitive Research Grants

Primary Objective: Support of an individual performing research in selected high-priority areas related to plant science and human nutrition.

Time in Effect: 1978 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$14,766,176	193	$76,509	1-5 years

Award Decision Process: Peer review.

Cost Sharing: Not required.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

Other Significant Characteristics: The competitive grants complement the research of the traditional agricultural research community by obtaining the participation of research scientists throughout the entire U.S. scientific community. Recipients include academic, industrial, and other government organizations. Colleges and universities receive 90 percent of the total funds.

USDA
Individual Research Project (Forest Service)

Primary Objective: Support of an individual performing research.

Time in Effect: 1954 to present.

	Fiscal Year 1984			
	Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
Grants	$732,000	27	$27,111	2 years
Contracts	132,000	7	18,857	1.5 years
Cooperative agreements	6,225,000	357	17,436	2 years
Total	$7,089,000	391		[a]

[a]Not available

Award Decision Process: Internal review.

Cost Sharing: Cooperative agreements. 20 percent required. Grants and contracts: cost sharing not required, but encouraged.

Indirect Costs: Cooperative agreements: not allowed. Grants and contracts: reimburse at full negotiated indirect cost rate.

Other Significant Characteristics: The majority (88 percent) of these awards are made through cooperative agreements as it is Forest Service policy for its scientists to work closely with the research scientists at the universities.

USDA Individual Research Project (Agricultural Research Service)

Primary Objective: Support of an individual performing research.

Time in Effect: 1937 to present.

	Fiscal Year 1984			
	Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
Grants	$5,011,220	22	$227,782	3 years
Contracts	631,915	16	39,494	3 years
Cooperative agreements	45,489,667	565	80,512	3 years
Total	**$51,132,802**	**603**		**3 years**

Award Decision Process: Internal review. In 1985 will begin to use more external reviewers of proposals

Cost Sharing: Cooperative agreements: cost sharing is not required. Grants and contracts: not required, but indirect costs are treated as cost sharing.

Indirect Costs: Cooperative agreements. reimbursement of indirect costs are not allowed by statute. Grants and contracts. allowable, but are usually negotiated out and treated as cost sharing.

Other Significant Characteristics. The awards are largely made through cooperative agreements (89 percent) because of the collaboration required between the agency and university researchers.

NIH
New Investigator Award (Grant)

Primary Objective: To support the basic and clinical studies of newly trained investigators so that they remain active during the developmental stages of their careers.

Time in Effect: 1971 to present.

Fiscal Year 1984			
Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$40,140,651	812	$49,610	3 years

Award Decision Process: Peer review.

Cost Sharing: 3-5 percent.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

NSF Presidential Young Investigator Award

Primary Objective: This award provides initial support for promising young scientists and engineers.

Time in Effect: 1984 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$23,800,000	200	$59,000	5 years[a]

[a]Nonrenewable.

Award Decision Process: Special two-tier panel review by outside experts: first tier is within disciplines, second tier selects across disciplines from leaders in first-tier evaluation.

Cost Sharing: Statutory cost sharing for first $25,000 of annual amount averaged over institution with 1-percent minimum on each award. NSF will match up to $37,500 of additional industrial cost sharing for specific awards for a maximum of $62,500 per year from NSF and $37,500 from industry.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

Other Significant Characteristics. This program encourages coupling between industry and acade[illegible], as well as attracts promising young people to academic careers.

DOD
Young Investigator Award (Contract)

Primary Objective: To identify young scientists and engineers who show exceptional promise for doing creative research and to support their research.

Time in Effect: New program, 1985.

Fiscal Year 1985[a]			
Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$600,000 committed	12	$50,000[b]	3 years

[a]No program in 1984, new program beginning 1985

[b]As reported by agency, this is minimum value of award.

Award Decision Process: Internal review.

Cost Sharing: Not required.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

DOE
Young Investigators in High Energy Physics

Primary Objective: To give initial research support to recent Ph.D. physicists.

Time in Effect: 1975 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$1,000,000	15	$50,000	3 years[a]

[a]Nonrenewable.

Award Decision Process: Peer review.

Cost Sharing: Not required.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

NIH
Career Awards (Grant)

Primary Objective: Support for developing an individual's career in research through performance of research in new areas.

Time in Effect: 1968 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$35,588,223	830	*	5 years

*Not included because of great variation in the awards.

Award Decision Process: Peer review.

Cost Sharing: Not required.

Indirect Costs: Reimburse up to 8 percent of total allowable direct costs.

Other Significant Characteristics: In the early 1970's, NIH's traditional training awards were terminated, and the National Research Service Awards (NRSA) authorization was passed. NRSA training awards have a payback provision and cannot be awarded to persons pursuing a health professional degree (M.D., D.O., D.D.S.). The career development awards allow NIH the flexibility of providing for research guided by a mentor without the NRSA provisions.

There are four variations of these awards:

- Research Scientists Award for an established scientist ($989,562. 19 awards);
- Modified Research Career Development Award for young scientists ($22,854,780: 583 awards);
- Clinical Investigator Award for medical scientists ($9,495,776: 191 awards); and
- Physician Scientist Award for clinicians ($2,248,105: 37 awards).

NIH Research Career Award (Discontinued for New Awardees)

Primary Objective: To provide stable career positions for established investigators of high competence.

Time in Effect: 1961-1964. Last new award made in 1964, but original awardees still receive annual supplements.

How Large an Effort	
Total Funding Level	Number of Awards
$82,000,000 expended, as of 1984	60 awards in 1984

Award: The award was a grant for salary support until retirement. Recipients still competed for project grants to perform research. Preference was given to scientists 44 years old or younger.

Evaluations: A recent evaluation of this mechanism, performed by NIH, found that the research career recipients performed as well as, and in some cases better than, their contemporaries in their subsequent careers. (The Research Career Award (K06): A 20-year Perspective on and Analysis of Research Productivity. Sept. 1984.)

DOE Distinguished Scientist/Engineer Grants (Discontinued)

Primary Objective: To support individual investigators performing fossil energy research.

Time in Effect: 1978-1979.

How Large an Effort	
Total Funding Level	Number of Awards
$1,200,000	5

Award: Three-year grants were totally funded the first year. Grants were awarded for peer-reviewed proposals from distinguished scientists and engineers, as evidenced by having received an award from a scientific or professional society.

Reason for Implementation: This program was intended to promote wider participation by distinguished academic scientists and engineers in the academic community in fossil energy research as opposed to more exotic areas of research.

Reason for Termination: The administering office was reorganized and its budget sharply cut.

NSF Research Initiation Grants (Engineering and Information Science)

Primary Objective: This award provides an opportunity for new faculty to initiate research.

Time in Effect: early 1960's to present.

Fiscal Year 1984			
Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$8,980,000	227	$40,000	2 years[a]

[a]Nonrenewable.

Award Decision Process: Peer review.

Cost Sharing: Statutory cost sharing averaged over institution with 1-percent minimum on each award.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

Other Significant Characteristics. These grants are designed to assist beginning engineering faculty members. This program is being replaced largely by the Presidential Young Investigators Awards.

NIH
AREA Grant
(Academic Research Enhancement Award)

Primary Objective: These research awards are made only to small colleges. The primary objective of the program is to assist researchers in such institutions in developing the research expertise and data necessary to qualify for the larger NIH Individual Research Project mechanism.

Time in Effect: New program, 1985.

Fiscal Year 1985*			
Total Funding Level	Number of Awards (estimate)	Average Award Size (estimate)	Average Duration of Award
$5,000,000	70	$70,000	up to 2 years

*No program in 1984, new program beginning in 1985

Award Decision Process: Peer review.

Cost Sharing: 3-5 percent.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

NIH
Small Grant

Primary Objective: This is a small, nonrenewable research grant for preliminary, short-term projects. This grant provides flexibility for initiating studies.

Time in Effect: 1982 to present.

Fiscal Year 1984			
Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$2,721,345	147	$18,513	1 year

Award Decision Process: Peer review.

Cost Sharing: 3-5 percent.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

DOE Indirect Funding of University Research/ Training Through DOE Laboratories and Operating Contractors[1]

Primary Objective: DOE policy is to maximize, to the extent possible, the use of DOE laboratory research facilities and resources in enhancing and strengthening university research and training.

Total Funding Level in Fiscal Year 1984: $550,000,000.

Other Significant Characteristics: A significant proportion of DOE's university research funding is provided indirectly through the National Laboratories and other operating contractors:

- subcontracts to university faculty;
- summer and academic year research/training appointments at DOE labs for faculty/students (about 1,400 appointments in 1984);
- use of DOE laboratory facilities by university scientists (At the nine major multiprogram labs, about 57 percent of the total operating time of designated user research facilities at the laboratories is used by university scientists. There are about 50 designated user research facilities in the DOE laboratory complex); and
- graduate student research at DOE labs (about 4,000 graduate students annually).

[1]Although not a formal funding mechanism as defined in this report, we include this description because DOE emphasized its importance in funding research performed by university scientists.

Appendix III

Program Support

NIH
Program Project Grants

Primary Objective: A sy tem of research activities and projects directed toward a well-defined research program. It may also support certain basic resources used by the groups in the program.

Time in Effect: 1962 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$285,559,747	449	$687,886	4 years

Award Decision Process: Peer review.

Cost Sharing: 3-5 percent.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

NSF
Research Program

Primary Objective: Support for a number of investigators in a coherent area of research.

Time in Effect: 1950's to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$80,000,000	78	$1,000,000	2-3 years

Award Decision Process: Standard NSF peer review with added emphasis on site visits. Large projects require National Science Board approval.

Cost Sharing: Negotiated in each case.

Indirect Costs: Reimburse at full negotiated indirect cost rate (reimbursed on the basis of direct costs less major equipment, according to NSF).

Other Significant Characteristics: Uses mostly grants (94 percent of awards), but contracts (3 percent) and cooperative agreements (4 percent) are also used depending on the nature of the project.

NASA Joint University Program Grants

Primary Objective: To accelerate the integration of new control technologies into the air traffic control system and to encourage graduate study in the area.

Time in Effect: 1979 to present.

Fiscal Year 1984			
Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$150,000	3	$50,000	3 years

Award Decision Process: Internal review.

Cost Sharing: According to NASA, use of cost-sharing clauses in university research awards is minimal.

Indirect Costs: Reimbur;e at full negotiated indirect cost rate.

NASA Computational Fluid Dynamics Training Grants

Primary Objective: To enhance graduate training and curriculum development and to purchase some equipment for computational fluid dynamics research.

Time in Effect: 1980-1984 (1984: last year of program).

Fiscal Year 1984			
Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$740,000	7	$105,714	9 months

Award Decision Process: Internal review.

Cost Sharing: According to NASA, use of cost-sharing clauses in university research awards is minimal.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

Other Significant Characteristics. This was designed as a 4-year program. It began initially as a training program, then expanded in scope.

DOD
Joint Services Program (Contract)

Primary Objective: To support groups of investigators performing research across disciplines in electronics sciences.

Time in Effect: 1940's to present.

Fiscal Year 1984			
Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$10,000,000	13	$2,300,000[a]	3 years

[a]Agency reported average award size of $2.3 million made for 3 years.

Award Decision Process: Internal review.

Cost Sharing: No requirement; a university may volunteer to share costs.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

Other Significant Characteristics According to information provided by DOD, at the close of World War II continued need for DOD sponsorship of basic research in electronic sciences was anticipated. As a result, the Joint Services Program was initiated and now consists of 13 research institutions.

DOE
Research Program (Contract)

Primary Objective: Support for a team of researchers in high-energy and nuclear physics.

Time in Effect: 1950's (AEC) to present (DOE).

Fiscal Year 1984			
Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$42,263,000	51	$768,418	2 years

Award Decision Process: Peer review. There is an advisory DOE/NSF High Energy Physics Review Panel.

Cost Sharing: Not required.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

Other Significant Characteristics. Contracts are used for these awards as they are largely for work to build customized equipment to detect particles of matter. The equipment is built for a specific purpose and shifted to a national laboratory on completion. The results obtained at the national laboratory are returned to and analyzed at the university. Title to the equipment belongs to the university, and when the experiment is completed, each piece of equipment is returned to the university as it is too specialized to be of use at the national laboratory.

Appendix IV
Center Support

NIH Research Center Core Grants

Primary Objective: To provide support for shared resources and facilities for specified research by a number of investigators from different disciplines.

Time in Effect: 1976 to present.

Fiscal Year 1984			
Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$83,133,145	124	$708,260	4 years

Award Decision Process: Peer review.

Cost Sharing: 3-5 percent.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

NIH
Specialized Research Center Grants

Primary Objective: Award for support of core research facilities and associated projects for a multidisciplinary attack on a specific disease entity.

Time in Effect: 1975 to present.

	Fiscal Year 1984			
	Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
Grant	$119,042,056	156	$904,149	*
Contracts	8,939,539	31	288,372	*
Total	**$127,981,595**	**187**		**4 years**

*Not available.

Award Decision Process: Peer review.

Cost Sharing: 3-5 percent.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

NIH Comprehensive Research Center Grants

Primary Objective: Award for core facilities, associated projects, extension or outreach service to foster biomedical research and development and to initiate education and counseling programs.

Time in Effect: 1976 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$29,016,920	29	$1,111,051	3 years

Award Decision Process: Peer review.

Cost Sharing: 3-5 percent.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

NIH Research Resources Center Grants

Primary Objective: Award to develop and ensure the availability of resources essential to the efficient and effective conduct of human health research.

Time in Effect: 1964 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$113,028,435	193	$585,639	3 years

Award Decision Process: Peer review.

Cost Sharing: 3-5 percent.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

Other Significant Characteristics: Center awards are made in the following areas:

- General Clinical Research Center—a discrete unit of research beds (1984: $69,030,107);
- Animal Resource Center (1984: $5,157,027);
- Biotechnology Resource Center (1984: $20,568,262); and
- Primate Research Center (1984: $18,273,039).

NSF Engineering Research Centers

Primary Objective: To provide for research initiation with industry, and for both undergraduate and graduate education support through curriculum development and student involvement in research.

Time in Effect: 1984: none. New program, 1985.

Fiscal Year 1985[a]			
Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$10,000,000[b]	5	$2,000,000	5 years

[a]No program in 1984, new program beginning in 1985.

[b]5-year commitment of $94,000,000.

Award Decision Process: (142 proposals) peer review, significant fraction of reviewers were from industry.

Cost Sharing: No requirement. But, NSF expects the universities to develop industrial support over time.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

Other Significant Characteristics:

Five awards:

- Massachusetts Institute of Technology: Biotechnology Processing
- Columbia: Telecommunications Research
- University of Delaware: Manufacture of Composite Materials
- Purdue: Intelligent Manufacturing
- University of California, Santa Barbara: Robotics Engineering

Emphasis on areas important to international competitiveness.

Each center has an industrial advisory committee.

NSF
Research Resources
Grants

Primary Objective: This award provides for resources such as living organism stock centers, biological field research facilities, and systematic epidemiology and anthropology research collections.

Time in Effect: 1972 to present.

Fiscal Year 1984			
Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$9,150,000	129	$71,000	3 5 years

Award Decision Process: Peer review.

Cost Sharing: Statutory cost sharing; averaged over institution with 1-percent minimum on each award.

Indirect Costs: Reimburse at full negotiated indirect cost rate except for marine and freshwater laboratories, where there is no indirect cost in lieu of cost sharing.

NSF
Research Centers

Primary Objective: To provide support for research facilities available to qualified scientists nationwide.

Time in Effect: 1965 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$11,500,000	9	$1,300,000	2-3 years

Award Decision Process: Standard NSF peer review with added emphasis on site visits; large projects require National Science Board approval.

Cost Sharing: Statutory cost sharing, averaged over institution with 1-percent minimum on each award.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

NSF Industry-University Cooperative Research Centers

Primary Objective: To stimulate industrial support of university research by creating centers of long-term collaboration between university and industry in research areas of high mutual interest.

Time in Effect: 1973 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$3,000,000	30	$25,000 to $50,000[a]	1 year[b]
		$250,000 to $500,000[c]	4-5 years[d]

[a]Planning grant.

[b]Planning period.

[c]Operation grant.

[d]Continuation period.

Award Decision Process: Combination of external and internal peer review.

Cost Sharing: Cost sharing by industry is required to qualify for continued support. Not required by university.

Indirect Costs: Yes, unless the rate is reduced as cost sharing.

Other Significant Characteristics: Initiates university research programs with industry cofunding. All centers are expected to increase the industrial support covering both direct research funding and equipment for their research program as NSF support is phased out. The center is expected to become self-sufficient within a period of 5 years.

A center is considered a success when its research funding is at its original level or higher and NSF no longer provides support.

NASA
Center of Excellence
(Grant)

Primary Objective: To develop unique expertise, foster interdisciplinary research, establish a group of researchers, and train graduate students.

Time in Effect: Mid-to-late 1970's to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
\$2,250,000*	5	\$450,000*	1-3 years

*GAO estimate. Agency reported a range of \$400,000 to \$500,000 per award

Award Decision Process: Internal review.

Cost Sharing: According to NASA, the use of cost-sharing clauses in university research awards is minimal.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

NASA
Joint University Institutes (Grant)

Primary Objective: To provide support for groups of investigators performing research to enhance research and training capability.

Time in Effect: 1970 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$2,776,000	3	$925,333	5 years

Award Decision Process: Internal review.

Cost Sharing: According to NASA, the use of cost-sharing clauses in university research awards is minimal.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

DOD
Centers for Research
(Contract)

Primary Objective: These centers both support research and increase the number of trained scientists.

Time in Effect: 1980 to present.

Fiscal Year 1984			
Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$7,996,851	6	$1,332,809	3.5 years

Award Decision Process: Internal review by DOD experts, and peer review.

Cost Sharing: Not required; may be volunteered by university.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

Other Significant Characteristics: Centers exist in three areas:

- Artificial Intelligence,
- Mathematics Sciences,
- Rotary Wing Aircraft Technology.

DOE
Fossil Energy Centers

Primary Objective: To convert former government-owned laboratories to university-owned laboratories.

Time in Effect: 1950's to present.

Fiscal Year 1984			
Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$15,716,000	2	$7,858,000	5 years

Cost Sharing: Not required.

Indirect Costs: Reimburse at full negotiated indirect cost rate, but negotiated individually.

Other Significant Characteristics: These are cooperative agreements as DOE plans to continue its involvement in developing research program priorities. Conversion of these laboratories began 2-3 years ago when DOE decided long-range coal research belonged more appropriately with the universities. The cooperative agreements are for 5 years with a declining annual rate of support. According to a DOE official, DOE will probably maintain some minimum level of support at these centers when the cooperative agreements end. These centers may compete for additional funding support from DOE along with other universities, the DOE laboratories, and industry.

DOE
On-Campus Research Centers

Primary Objective: To support problem-oriented research of a long-term nature.

Time in Effect: 1950's (AEC) to present (DOE).

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$35,100,000	13	$2,700,000	5 years

Award Decision Process: Internal review.

Cost Sharing: Not required.

Indirect Costs: Reimburse at full negotiated indirect cost rate. May be different from institutional rate as the equipment and sometimes the building belong to DOE.

Other Significant Characteristics: DOE owns the equipment and may own the building. The laboratory is located on a university campus and is staffed by both full-time researchers and faculty. DOE is primarily responsible for full support of research at these centers, although some researchers may receive small awards from other sources.

These awards are for support of research at an established center. Please refer to "Specialized Facility Construction" and "Accelerator Acquisitions" in Major Equipment and Facilities section, to see the variety of ways in which these centers were initially established.

Appendix V

Special Training Needs

NIH National Research Service Award (NRSA) Postdoctoral Fellowship Grants

Primary Objective: Support for postdoctoral research training to broaden scientific background and extend research potential.

Time in Effect: 1975 to present.

Fiscal Year 1984			
Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$21,856,509	1,223	$17,871	2 years

Award Decision Process: Peer review.

Cost Sharing: Not required.

Indirect Costs: Reimburse up to 8 percent of total allowable direct costs.

Other Significant Characteristics: NRSA fellowships are similar to pre-1975 NIH fellowships with two exceptions: NRSA awards are subject to payback provisions and cannot be granted to a person pursuing a health professional degree (M.D., D.D.S., etc.).

NIH National Research Service Award (NRSA) Predoctoral Fellowship Grants

Primary Objective: Awards to predoctoral individuals for supervised research training leading to a research degree.

Time in Effect: 1981 to present.

Fiscal Year 1984			
Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$362,388	39	$9,292	4 years

Award Decision Process: Peer review.

Cost Sharing: Not required.

Indirect Costs: Reimburse up to 8 percent of total allowable direct costs.

Other Significant Characteristics: NRSA awards are subject to payback provisions and cannot be awarded to a person pursuing a health professional degree.

NIH National Research Service Award (NRSA) Training Grants

Primary Objective: Awards to universities to provide research training in specified shortage areas.

Time in Effect: 1975 to present.

Fiscal Year 1984			
Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$117,895,885	1,069	$113,379	5 years

Award Decision Process: Peer review.

Cost Sharing: Not required.

Indirect Costs: Reimburse up to 8 percent of total allowable direct costs.

Other Significant Characteristics: Grants are also available for off quarters or summers to encourage research in areas of national need (92 awards for $2,552,411 in fiscal year 1984). The NRSA program, initiated in 1975, grants awards similar to the training grants issued before 1975, with two exceptions: NRSA awards are subject to payback provisions and cannot be granted to individuals pursuing a degree in one of the health professions.

NIH National Research Service Award (NRSA) For Senior Fellows

Primary Objective. Award to allow experienced scientists to make major changes in the direction of research careers and to acquire new research capabilities.

Time in Effect: 1980 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$536,479	18	$29,804	1 year

Award Decision Process: Peer review.

Cost Sharing: Not required.

Indirect Costs. Reimburse up to 8 percent of total allowable direct costs.

Other Significant Characteristics. NRSA awards are subject to payback provisions.

NSF
Graduate Fellowship

Primary Objective: To encourage very capable students to go into science and engineering.

Time in Effect: 1950's to present.

Fiscal Year 1984			
Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$20,300,000	1,460	$13,900	3 years*

*Nonrenewable.

Award Decision Process: External panels place applicants in Quality Group 1 (QGI) and Quality Group 2 (QGII). All QGI applicants are offered awards. Using criteria (geographic, disciplinary, etc.), awards are made to QGII.

Cost Sharing: Not required.

Indirect Costs: No reimbursement; award provides a cost-of-education allowance.

Other Significant Characteristics: There is a subcategory restricted to minority students in order to give them special encouragement.

NSF Postdoctoral Fellowship

Primary Objective: To provide support to begin a research career in mathematics or plant biology.

Time in Effect: 1979 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$3,500,000	67	$52,000[a]	2 years[b]

[a]Award is for 2 years

[b]Nonrenewable

Award Decision Process: For mathematics award: external peer review by contractor (American Mathematical Society). For plant biology: standard NSF peer review.

Cost Sharing: Not required.

Indirect Costs: No reimbursement of indirect costs; award includes an institutional allowance.

NSF
Doctoral Dissertation Research Improvement Awards (Grant)

Primary Objective: To provide support for the costs of field research in certain areas of the biological and social sciences.

Time in Effect: Early 1960's to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$1,190,000	189	$6,000	[a]

[a]Nonrenewable.

Award Decision Process: Peer review.

Cost Sharing: Not required.

Indirect Costs: Not allowed.

NSF
National Needs Postdoctoral Fellowship (Discontinued)

Primary Objective: Fellowship support to recent Ph.D. recipients for study.

Time in Effect: 1952-1981. (Last new award was made in fiscal year 1980.)

How Large an Effort: Approximately 3,857 individuals.

Award: Did not include travel, dependents' or allowance support. Usually 1 year. A cost-of-education allowance was provided to the institution.

NSF
Graduate Research Traineeship (Discontinued)

Primary Objective: To provide support for training.

Time in Effect: 1964-1973.

How Large an Effort: Approximately 8,140 awards.

Award: Awards were grants to the institution for 12 months of support Award did not reimburse indirect costs and did not require cost sharing.

Reason for Termination: Budgetary restrictions.

Other Significant Characteristics: From 1966 to 1971, there were also summer fellowships for graduate teaching assistants A Minority Institution Graduate Traineeship program (1974, 1977-1981) was designed to improve access to careers in science for graduate students who were attending predominantly minority colleges and universities.

NSF
Senior Postdoctoral Fellows (Discontinued)

Primary Objective: To provide individuals with an opportunity to supplement their training by additional study or research.

Time in Effect: 1956-1971.

How Large an Effort	
Total Funding Level	Number of Awards
$11,440,000	1,132

Award: The grant was an award for 3 months to 24 months, usually used for a sabbatical. It could not be used to cover travel.

Reason for Termination: NSF determined that the better way to support individual investigators was through research projects.

NSF
Senior Foreign Scientist Fellowships (Discontinued)

Primary Objective: To provide salary support to outstanding foreign scientists to work in a U.S. research university for 1 year.

Time in Effect: 1963-1971.

How Large an Effort: Approximately 523 scientists.

Award: Award included stipend, travel costs, and a small allowance for supplies. Indirect costs were not allowed, and there was no cost-sharing requirement.

Reason for Implementation: To bring foreign scientists to the United States whose training, teaching, and research experience would enable them to make significant contributions to science education and research capabilities at the host universities.

Reason for Termination: Budgetary restrictions.

Other Significant Characteristics: There was a variation of this program in 1975 (the only year in effect), the "Visiting Foreign Energy Scholars Program." This award provided salary support to 20 foreign energy specialists totaling $400,000.

NASA Graduate Student Researchers Program

Primary Objective: Graduate student support to increase the number of highly trained aerospace scientists and engineers.

Time in Effect: 1980 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
\$1,800,000	120	\$15,000[a]	3 years

[a]\$12,000 for stipend, \$3,000 cost-of-education allowance.

Award Decision Process: Internal review.

Cost Sharing: Not required.

Indirect Costs: No reimbursement of indirect costs. University receives a cost-of-education allowance.

Other Significant Characteristics: Plan to double annual awards in 1985 and to begin peer review of proposals.

DOD Graduate Fellowship Program

Primary Objective. Support for fellowships to graduate students at universities of their choice.

Time in Effect: 1982 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$3,000,000	140[a]	$20,000 to $25,000[b]	3 years

[a]70 are new, 70 are continuing

[b]Includes student and university allowances

Award Decision Process. Navy and Air Force have a panel review with service and academic representatives. Army conducts an internal review.

Cost Sharing: Not required.

Indirect Costs. No reimbursement. However, a university cost-of-education allowance is part of awards from Navy and Army.

Other Significant Characteristics. The funding levels for this program have increased steadily since its inception. There is a planned increase to about $5,000,000 in 1985.

Navy and Air Force use a fellowship agreement; Army uses a grant.

Implemented in response to a shortage of scientists and engineers, which, although national in scope, is particularly severe for DOD. Part of DOD effort to reverse a decade-long (1965-1975) decline in DOD's support of basic research.

AEC/DOE Traineeships (Discontinued)

Primary Objective: Support to universities for graduate students in energy sciences.

Time in Effect: 1966-1982.

How Large an Effort	
Total Funding Level	**Number of Awards**
$10,000,000 (estimate)	1,568

Reason for Implementation: To develop a broader base of educational institutions regionally and nationally.

Reason for Termination: By early 1980's were supporting only 100 people, needed to support 1,000. Decided that if they could not fund enough people to have a significant effect on need, would drop the program.

Other Significant Characteristics: This was an agency-wide program. With its discontinuance, the only mechanism left for training is the research fellowships offered by offices within DOE that are very specialized and decentralized.

AEC/DOE Fellowships (Discontinued)

Primary Objective. Support to encourage top-quality science and engineering students to enter the field of nuclear science and its related applications.

Time in Effect: 1948-1973.

How Large an Effort	
Total Funding Level	**Number of Awards**
$20,000,000 (estimate)	2,556

Reason for Implementation: To aid in the transition of nuclear technology from a war-time footing to civilian activities.

Reason for Termination. Agency funding decreased, and the civilian nuclear power program was maturing, so the need for encouraging development of scientists was not as great.

DOE
Graduate Research Fellowships (Contract)

Primary Objective: Support for graduate fellowships in areas of assessed manpower needs in selected energy technology areas.

Time in Effect: 1982 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$1,395,000	54	$18,000[a]	3 years

[a]$12,000 to student; $6,000 to university

Award Decision Process: Peer review.

Cost Sharing: Not required.

Indirect Costs: No reimbursement of indirect costs; university receives $6,000 for tuition and other educational expenses.

Other Significant Characteristics. Administered by the Oak Ridge Associated Universities, a DOE operating contractor.

USDA Food and Agricultural Sciences National Needs Fellowships (Grant)

Primary Objective: Training to develop scientists to meet the nation's emerging needs in food and agricultural research.

Time in Effect: 1984 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$5,000,000	67[a]	up to $190,000	5 years

[a]Award is made to university and covers expenses for 1 year to recruit and 3 years of support in a 4 year period.

Award Decision Process: Peer review.

Cost Sharing: Not required.

Indirect Costs: No reimbursement of indirect costs.

Other Significant Characteristics: All colleges/universities are eligible.

Appendix VI

Major Equipment and Facilities

NIH
Research Facilities
Construction Grants

Primary Objective: Matching funds for construction or major remodeling to create new research facilities.

Time in Effect: 1972 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$700,000	2	$350,000	1 year

Award Decision Process: Peer review.

Cost Sharing: 50-percent matching funds required.

Indirect Costs: No reimbursement of indirect costs.

NIH
Health Research
Facilities
(Discontinued)

Primary Objective: Support for construction, remodeling, alteration, and equipping new and existing buildings to be used for research in health-related sciences.

Time in Effect: 1957-1972.

How Large an Effort: $535 million.

Award: Grant matched up to 50 percent of construction needs.

NSF
Specialized Research
Facilities and
Equipment Grants

Primary Objective: To provide the equipment and facilities required for the conduct of very advanced research projects.

Time in Effect: 1952 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$32,900,000	512	$64,000	1 year[a]

[a]Nonrenewable.

Award Decision Process: Peer review.

Cost Sharing: Varies, depending on the size of the award and the discipline. Typically it is 50 percent, but may be less if the total cost is large.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

NSF Graduate Research Facilities Grants (Discontinued)

Primary Objective: To provide buildings and equipment for research at universities.

Time in Effect: 1960-1970.

How Large an Effort	
Total Funding Level	Number of Awards
$188,200,000	977

Award: 50-percent matching grants to universities offering doctoral work in science and engineering basic research. Standard NSF peer review was used to determine recipients.

Reason for Termination: Further facilities awards judged to be of lesser priority than research awards when NSF budget was reduced.

Evaluations: National Board on Graduate Education. "Science Development, University Development and the Federal Government," June 1975, and companion "Science Development. An Evaluative Study" by Davis Drew, June 1975.

Fred Stafford: NSF Science Development Programs. NSF 77-17.

DOD University Research Instrumentation Grants

Primary Objective: Support for instrumentation.

Time in Effect: 1983 to present.

Fiscal Year 1984			
Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$30,000,000	237 grants	$132,557	1 year

Award Decision Process: Internal review.

Cost Sharing: Not required, but encouraged.

Indirect Costs: No reimbursement. Award is solely for acquisition of equipment.

Other Significant Characteristics: Other than support provided on regular DOD research projects, this is DOD's major instrumentation program.

Part of DOD effort to reverse a decade-long decline in DOD's support of basic research.

Many new proposals utilizing this equipment have been supported under DOD research projects.

AEC/DOE Specialized Facility Construction

Primary Objective: This is not a program, but a series of actions taken to provide for, or assist in, the construction of specialized facilities on an ad hoc basis.

Specialized Facility Construction: Funds were allocated variously by congressional action as a budget line item or through support through a user fee over a 10-year period to cover the construction costs that the university had originally paid.

Five such facilities:

1. Notre Dame Radiation Laboratory

- line item added by the Congress

1961 $750,000

1962 $1,450,000.

- it has been continuously supported by AEC/DOE since 1963 on a special-cost type contract.

(DOE funding 1978-1985 was $19,487,000.)

2. Materials Research Building at University of Illinois

- built in 1963.
- 80 percent funds from DOD.
- 20 percent funds from AEC through a user fee over a 10-year period.

(DOE funds to this facility 1978-1985 were $32,290,000.)

3. Plant Sciences Laboratory at Michigan State University

- AEC paid a user fee over 10-year period to offset the cost of construction borne by the university.

(DOE funds to this facility 1978-1985 were $12,490,000.)

4 Courant Applied Mathematics and Computer Science Institute at New York University

- AEC provided core of institute; i.e., the Univac #4 Computer.

(DOE funds to this facility 1978-1985 were $13,731,000.)

5. Institute of Molecular Biophysics at Florida State University

- building was constructed with university funds early 1960's.
- AEC provided 10-year block award for staff and operating expenses, then institute switched to individual research contracts.

(DOE funds to this facility 1978-1985 were $1,931,000 plus $7,000,000 in fiscal year 1985 for initiation of the Super Computer Computational Research Institute.)

AEC/DOE
University Accelerator Acquisitions

Primary Objective: To establish university accelerator facilities.

Reason for Implementation: To build university capabilities in nuclear science.

University Accelerator Acquisitions: AEC was established to take the wartime accelerator facilities for the Manhattan Project and to continue them for nonmilitary use. AEC uses two means for this: national laboratories and university laboratories. The trend, due to the evolving nature of the research and the current complexity and large expense of the equipment, has been to place more emphasis on the national laboratories. Four universities, however, maintain their accelerators: Duke, University of Washington, Yale, and Texas A&M. These are maintained because DOE recognizes a need to train future high-energy physicists. The major activity now is upgrading the facilities and equipment they have. There has been no new construction development for 20 years, although there are currently plans for a facility to be located in Newport News and to be managed by the Southeastern Universities Research Association.

Each accelerator facility has its own history. some were built by the university; some were joint projects. Some of those retired from regional use by DOE are still in use by other federal or private programs.

Some examples:

- Massachusetts Institute of Technology's (MIT's) Bates Linear Accelerator: Built in the 1965-1972 time period. Congressional action placed $5,700,000 in AEC budget, and MIT contributed $1,500,000. It received operating support from AEC and continues to receive such support from DOE. With modifications over the years, its current replacement cost is estimated to be over $60,000,000. (This is actually a national laboratory facility located on MIT's campus.)
- Texas A&M's Cyclotron: The Welsh Foundation provided a "kick-off" grant of $1,000,000 in 1965. Texas A&M provided $2,000,000, and AEC provided $3,000,000. This facility continues in operation with support from DOE and the state of Texas.
- Yale University's Heavy Ion Accelerator: Built as a result of a congressional line item addition to the budget. It is no longer operating and has been dismantled.

DOE
University Research Instrumentation Grant Program

Primary Objective: Support for research instrumentation.

Time in Effect: 1984 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$3,976,000	17	$225,000	1 year[a]

[a]Nonrenewable.

Award Decision Process: Peer review and internal review.

Cost Sharing: Encouraged but not required: however, in 1984 cost sharing was used as one of the evaluation criteria in reviewing and ranking the proposals.

Indirect Costs: No reimbursement for indirect costs. Award is solely for purchase of instrument.

DOE
Used Energy-Related Equipment Program

Primary Objective: Support of equipment needs for energy-related research capability at universities.

Time in Effect: 1969 (AEC) to present (DOE).

Fiscal Year 1984	
Total Funding Level	Number of Awards
No funds are required to suppport this program	20

Award Decision Process: Internal review.

Cost Sharing: N/A, nonfunded effort.

Indirect Costs: N/A, nonfunded effort.

Other Significant Characteristics: University scientists/administrators receive monthly listings of surplus equipment from DOE labs. These items are made available on a first-come-first-served basis, subject to a brief proposal for how the equipment will be used for research or education. The university receiving the equipment is responsible for crating and shipping costs. Title to the equipment is given to the university.

In fiscal year 1985, 88 awards were made under this program.

USDA 1890 Research Facilities Program

Primary Objective. Support for facilities at the 17 predominantly black 1890 land-grant colleges and Tuskegee University.

Time in Effect: 1983 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$9,600,000	17	$564,706	Not limited

Award Decision Process. Formula program not subject to competitive renewal. Available only to 1890 land-grant colleges and Tuskegee University.

Cost Sharing: Not required.

Indirect Costs. Authorizing legislation prohibits payment of any overhead costs.

USDA
Agricultural Research Facilities Act

Primary Objective: A formula grant to all agricultural experiment stations to build facilities.

Time in Effect: 1963 to present. Last award 1970.

Total Funding Level: 1963-1970: $10,242,000.

Award Decision Process: Formula award to all agricultural experiment stations.

Other Significant Characteristics: This program provided for distribution of funds on a formula basis to all experiment stations. Given the funding levels for the act, the amount each station received was never very large. The total level required to make the program effective at the level of each station is prohibitive. Therefore, USDA has proposed revising the act to allow construction of individual, state-owned facilities on a matching basis.

Appendix VII

Institutional Support

NIH General Research Support Grants

Primary Objective: To complement the project system and to give institutions an increased measure of control over the quality, content, emphasis, and direction of their research activities.

Time in Effect: 1961-1975. In 1976 phased into Biomedical Research Support Grant Program.

Award Decision Process. Formula awards quantitatively related to the magnitude of Public Health Service research awards (which were peer reviewed) to that institution in the previous year. By relying on project support to decide award amounts, the program placed emphasis on evidence of merit and research excellence.

Other Significant Characteristics. Responsibility for establishing research priorities for the funds was left to the discretion of the grantee Initial awards were made in 1962 to health professional schools. The Congress authorized extension of this program to a separate Biomedical Sciences Support Grant, later known as Biomedical Research Support Grant. This program was identical to the General Research Support Grant, except that it was available to universities. (See following write-up on this program.)

In addition, the Congress authorized NIH to extend its use of institutional grants for the purpose of institutional advancement From this came the Health Sciences Advancement Award in 1966. Unlike the General Research Support Grants and the Biomedical Sciences Support Grants, which rewarded attained excellence as evidenced by having won project awards, the Health Sciences Advancement Award program emphasized promise and opportunity.

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NIH
Biomedical Research Development Grants (Discontinued)

Primary Objective: Program was created to upgrade new, small, developing institutions that could not qualify for the NIH Biomedical Research Support Grant. This program was the result of a congressional directive to provide support to institutions not extensively engaged in research but with demonstrated potential.

Time in Effect: 1977-1983. (Last new award in 1980.)

How Large an Effort: $9,600,000

Award: A competitive grant for up to 3 years.

Reason for Termination: Determination was made at NIH that the need for the program had diminished, as evidenced by the declining number of high-quality applications being submitted by research institutions.

Other Significant Characteristics This was a very focused program with definite objectives.

When the program was discontinued, funds were reallocated to the Biomedical Research Support Grant program.

NIH Biomedical Research Support Grants

Primary Objective: To strengthen, balance, and stabilize Public Health Service-supported biomedical and behavioral research programs through flexible funds awarded on a formula basis based on previous PHS research awards.

Time in Effect: 1976 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$36,892,858	392	$94,114	1 year

Award Decision Process: The university applies for it. Amount is determined using a formula based on PHS awards from the previous year. To be eligible, an institution must have at least three NIH grants worth $200,000.

Cost Sharing: Not required.

Indirect Costs: No reimbursement of indirect costs.

NIH Biomedical Research Support Grants— Shared Instrumentation

Primary Objective. To make available to institutions with a high concentration of NIH extramural research awards, research instrumentation that will be used on a shared basis.

Time in Effect: 1982 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$16,842,000	100	$169,970	1 year

Award Decision Process: Peer review.

Cost Sharing: Not required.

Indirect Costs: No reimbursement.

Other Significant Characteristics. A university that has received a Biomedical Research Support Grant applies for a shared instrumentation grant for use by at least three investigators with PHS support.

NIH
Health Sciences Advancement Award Program (Centers of Excellence) (Discontinued)

Primary Objective: To expand the national capability for research in the health sciences by increasing the number of distinguished biomedical research centers of excellence.

Time in Effect: 1966-1974. (Last new award 1969.)

How Large an Effort: $26,300,000

Award: Awards were competitive, nonrenewable grants for up to 5 years for payment of direct biomedical research and research training expenses. Allowable expenses had to be explained in a plan for advancement in the area of biomedical sciences developed by the recipient and approved by NIH. Recipients were those institutions judged to have potential to achieve growth, not schools that had already achieved eminence or that could not qualify for funding. There were no cost-sharing requirements, nor could the award be used for indirect costs.

Reason for Implementation. May be traced to the 1960 Seaborg Report, which recommended increasing the number of academic centers of excellence.

Other Significant Characteristics. This program was not meant to be a substitute for traditional support mechanisms such as research project grants, research program projects, or research training grants, nor was it intended to provide fluid funds for formula distribution. It was intended to allow institutions to pursue a plan for development of research excellence in biomedical research and research training.

Expenses for alteration or renovation of facilities up to $50,000 could be included only if it was clearly essential to conduct the approved program. Student support could be provided only on a specific short-term basis until traditional training support was available.

NIH
Minority Biomedical Research Support Grants

Primary Objective: To strengthen the biomedical research and research training capability of ethnic minority institutions in order to increase the involvement of minority faculty and students in biomedical research.

Time in Effect: 1972 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$29,253,264	220	$144,414	3 years

Award Decision Process: Peer review.

Cost Sharing: 3-5 percent.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

NSF
Research Improvement at Minority Institutions

Primary Objective: To support faculty research at predominantly minority colleges and universities in order to provide an improved research environment.

Time in Effect: 1982 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$2,500,000	10	$250,000	2-3 years*

*Nonrenewable.

Award Decision Process. Standard NSF peer review with site visits.

Cost Sharing: Statutory cost sharing (1 percent) is averaged on institution-wide basis.

Indirect Costs: Reimburse at full negotiated indirect cost rate.

Other Significant Characteristics. As well as supporting research, the award also assists in the acquisition of research equipment for minority colleges and universities.

A study of the predecessor of this program showed that research support from other sources for investigators under this program increased by a factor of two.

NSF Science Development Grants (Centers of Excellence) (Discontinued)

Primary Objective: To increase the number of institutions of recognized excellence in research and research education in the sciences.

Time in Effect: 1964-1972.

How Large an Effort: $233,000,000 for 102 universities.

Award: Awards were block grants competitively awarded on the basis of proposals submitted for plans to develop research capability. Universities receiving awards were reimbursed at the full negotiated indirect cost rate. Cost-sharing requirements were negotiated in each case.

Reason for Implementation: The Science Development Program was NSF's response to the 1960 Seaborg Report calling for a doubling of the nation's centers of excellence.

Other Significant Characteristics: This type of program represented a major change in policy, from using research excellence as a primary criteria for award, to using potential to develop research excellence as a primary criteria for award. The centers of excellence programs were essentially without precedent because of this changed orientation.

A major purpose of the program was to accelerate improvement in science through the provision of funds to be expended in accordance with a carefully developed plan. The plan was designed to produce significant upgrading in the quality of the institutions' science activities. Recipients were institutions judged to have the greatest potential to move upward to a higher level of scientific quality.

Begun as one program in 1965, when it was obvious some schools could not qualify for the original program, it was broken up into three programs in 1966: university science development program, departmental science development program, and college science development program (aimed at undergraduate schools).

Criteria for selection of awards:

1. Evidence of a plan for major upgrading to a significant level of quality within 3-5 years.

2. Presence of sufficient strength as a base for development.

3. Evidence of adequate financial resources to assure goals can be achieved and maintained.

Evaluations:

- National Board on Graduate Education, "Science Development, University Development and the Federal Government," June 1975, and companion: "Science Development: An Evaluative Study" by David Drew, June 1975.
- Fred Stafford. NSF Science Development Programs. NSF 77-17

NSF Institutional Grants for Science (Discontinued)

Primary Objective. This award was intended to sustain and improve the quality of academic science in institutions that had already shown evidence of quality through winning NSF research awards.

Time in Effect: 1961 to 1974.

How Large an Effort: $135,000,000 to at least 939 institutions.

Award. Grants were based on a formula using previous NSF research awards. These grants were extended to cover all federal (excluding PHS) awards in 1970. Grants were renewable annually and undesignated except that they had to be used for direct costs of research activities. University presidents were able to use their discretion as to how the award would be used.

Other Significant Characteristics. It was allowable to carry funds over from 1 year to the next.

NASA Sustaining Universities Program (Discontinued)

Primary Objective: To utilize universities in its mission-oriented programs, while at the same time strengthening rather than weakening the universities' traditional teaching function.

Time in Effect: 1962-1971.

How Large an Effort: $224,800,000

Award: A competitive grant program with three distinct elements: training, multidisciplinary research, and facilities.

Reason for Implementation: President Kennedy's goal of putting a man on the moon meant building and upgrading the nation's research and training capability in aerospace-related science. This program was designed to create a government/university/industry partnership.

Reasons for Termination: The Congress questioned in the appropriations and authorizations hearings of fiscal years 1964, 1965, and 1966 whether it was proper for a mission agency to support education.

NASA's budget dropped sharply in the late 1960's, and program was reduced with it.

In the late 1960's, the need for technical people had decreased, so the program appeared to be producing unneeded scientists.

Other Significant Characteristics: The multidisciplinary research portion provided the university with some discretion in fund usage. In addition, NASA pioneered the step-funding process, which was used with the research portion of this program. This process guaranteed an award recipient 3 years of support at decreasing levels. Each annual review would either add funds to bring the next 2 years up to full funding, or decide to allow the program to phase out.

The training portion, the largest part of the program (almost half), was unusual at the time, as it was not common for mission agencies to support graduate education.

The facilities portion had a unique feature, a memorandum of understanding, signed by the recipient university, stating it would try to apply its research capabilities to local problems.

DOD
University Research Initiative

Primary Objective. To improve the capacity of universities to perform scientific research and to produce quality scientific and engineering personnel.

Time in Effect: New initiative, begins in 1986.

Fiscal Year 1986*

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$25,000,000 requested	not determined	not determined	not determined

*No program in 1984. Program to start in 1986

Award Decision Process: Not determ' ied.

Cost Sharing: Not determined.

Indirect Costs: Not determined.

Other Significant Characteristics. Plans for the scope and implementation of this program are being developed with the cooperation and advice of the university community. One important objective of the program is to encourage the exchange of scientists and ideas among government, academia, and industry.

DOD
Project Themis
(Discontinued)

Primary Objective: Support of defense-related multidisciplinary research programs at universities not heavily engaged in research for the federal government.

Time in Effect: 1967-1971. (Last new start 1969.)

How Large an Effort: $95,500,000: Themis provided start-up funding for 118 interdisciplinary research programs at 76 universities.

Award: Contracts paid for salary, equipment, supplies, travel, publications, direct and overhead costs, but not construction. Awards were competitive block grants to universities who received less than $3,000,000 the previous year from DOD and were based on plans for development rather than proven expertise.

Reason for Implementation: DOD's response to President Johnson's letter of September 1965 requesting that federal departments enhance and broaden the base of the nation's academic competence in science and engineering.

Reason for Termination: In 1970 the Senate Armed Services Committee regarded Themis as an educational support program inappropriate for DOD funding. Ongoing research programs were incorporated into regular research programs.

Other Significant Characteristics: Provided for on-campus formulation and direction of the research programs, with great flexibility for responsiveness to fresh ideas and newly perceived opportunities.

Used step-funding technique to allow for a 3-year commitment of funds This was perceived as an incentive for the "have not" institutions who might not otherwise have the funds to attract researchers or graduate students.

The projects were chosen on the basis of both contributing to the long-range educational goals of the institution and the long-term research needs of DOD.

DOE
University Institutional Research Grants (Discontinued)

Primary Objective: To broaden and increase university participation in the national energy research and development effort. Designed to develop both research capability and manpower in energy research.

Time in Effect: 1976-1982.

How Large an Effort: $5,800,000

Award: A multiyear, peer-reviewed block research grant for interdisciplinary research.

Reason for Termination: Terminated in 1982 as part of an overall review of DOE research- and manpower-development programs and subsequent reduction of funds for programs not judged to be essential to the programmatic needs of DOE.

Evaluations: A DOE evaluation of this program showed that for every dollar DOE provided in the institutional research grant program, on average it was later determined that an additional $5 was received by the university research group from other DOE programs and/or from a combination of state, private foundation, or industrial support.

Other Significant Characteristics: Concentrated on universities with highest potential for contributing to energy research needs. Minimum criteria were: annual minimum funding level from DOE of $1,500,000; demonstrated energy R&D competence in at least two major energy programmatic areas; and a campus-wide administrative focus for energy research.

USDA
Hatch Act Formula Grants

Primary Objective: Support for research to promote a sound and prosperous agricultural and rural life.

Time in Effect: 1888 to present.

Fiscal Year 1984			
Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$144,134,842	57	$2,528,681	Not limited

Award Decision Process: This is a formula award to all agricultural experiment stations. Each eligible institution has primary responsibility for determining the need and feasibility of projects to be performed.

Cost Sharing: Matching requirement for funds in excess of $90,000, with exception of Guam, Virgin Islands, American Samoa, Micronesia, and Northern Mariana Islands, which may receive up to $200,000 without matching.

Indirect Costs: Does not reimburse indirect costs.

Other Significant Characteristics: Awards are made to the state agricultural experiment stations of the 50 states, District of Columbia, Puerto Rico, Guam, the Virgin Islands, Micronesia, and American Samoa.

USDA
Cooperative Forestry Research Grants (Mcintire-Stennis Act)

Primary Objective. To maintain university forestry research capability

Time in Effect: 1964 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$12,147,700	60 schools	$202,462	Not limited

Award Decision Process. This is a formula grant to all state-certified forestry research schools.

Cost Sharing: Requires equal matching on a dollar-for-dollar basis.

Indirect Costs: Does not reimburse indirect costs.

USDA
Evans-Allen Payments to 1890 Colleges and Tuskegee University

Primary Objective: Support to maintain research capability

Time in Effect: 1979 to present.

Fiscal Year 1984

Total Funding Level	Number of Awards	Average Award Size	Average Duration of Award
$21,866,625	17	$1,286,272	Not limited

Award Decision Process. Formula grants to the 1890 land-grant colleges and Tuskegee University.

Cost Sharing: Not required.

Indirect Costs: Does not reimburse indirect costs.

USDA
Animal Health and Disease Research Grants

Primary Objective: Support to maintain research capability.

Time in Effect: 1979 to present.

Fiscal Year 1984		
Total Funding Level	Number of Awards	Average Award Size
$5,496,422	67	$82,036

Award Decision Process: Award made on formula basis to eligible institutions.

Cost Sharing: Matching is required for amounts exceeding first $100,000.

Indirect Costs: Does not reimburse indirect costs.

Other Significant Characteristics Formula awards go to eligible schools and colleges of veterinary medicine and to state agricultural experiment stations whose purpose is to improve the health and productivity of food animals and horses.

Appendix VIII

List of Awards by Mechanism and Agency

Individual Project Support

NIH Individual Research Project
NSF Individual Research Project (Grant)
NASA Individual Basic Research Project
DOD Individual Research Project
DOE Individual Research Project
USDA Special Research Grants
USDA Competitive Research Grants
USDA Individual Research Project (Forest Service)
USDA Individual Research Project (Agricultural Research Service)
NIH New Investigator Award (Grant)
NSF Presidential Young Investigator Award
DOD Young Investigator Award (Contract)
DOE Young Investigators in High Energy Physics
NIH Career Awards (Grant)
NIH Research Career Award (Discontinued for new awardees)
DOE Distinguished Scientist/Engineer Grants (Discontinued)
NSF Research Initiation Grants (Engineering and Information Science)
NIH AREA Grant (Academic Research Enhancement Award)
NIH Small Grant
DOE Indirect Funding of University Research/Training Through DOE Laboratories and Operating Contractors

Program Support

NIH Program Project Grants
NSF Research Program
NASA Joint University Program Grants
NASA Computational Fluid Dynamics Training Grants
DOD Joint Services Program (Contract)
DOE Research Program (Contract)

Center Support

NIH Research Center Core Grants
NIH Specialized Research Center Grants
NIH Comprehensive Research Center Grants
NIH Research Resources Center Grants
NSF Engineering Research Centers
NSF Research Resources Grants
NSF Research Centers
NSF Industry-University Cooperative Research Centers
NASA Center of Excellence (Grant)
NASA Joint University Institutes (Grant)
DOD Centers for Research (Contract)
DOE Fossil Energy Centers
DOE On-Campus Research Centers

Special Training Needs

NIH National Research Service Award (NRSA) Postdoctoral Fellowship Grants
NIH National Research Service Award (NRSA) Predoctoral Fellowship Grants
NIH National Research Service Award (NRSA) Training Grants
NIH National Research Service Award (NRSA) for Senior Fellows
NSF Graduate Fellowship
NSF Postdoctoral Fellowship
NSF Doctoral Dissertation Research Improvement Awards (Grant)
NSF National Needs Postdoctoral Fellowship (Discontinued)
NSF Graduate Research Traineeship (Discontinued)
NSF Senior Postdoctoral Fellows (Discontinued)
NSF Senior Foreign Scientist Fellowships (Discontinued)
NASA Graduate Student Researchers Program
DOD Graduate Fellowship Program
AEC/DOE Traineeships (Discontinued)
AEC/DOE Fellowships (Discontinued)
DOE Graduate Research Fellowships (Contract)
USDA Food and Agricultural Sciences National Needs Fellowships (Grant)

Major Equipment and Facilities

NIH Research Facilities Construction Grants
NIH Health Research Facilities (Discontinued)
NSF Specialized Research Facilities and Equipment Grants
NSF Graduate Research Facilities Grants (Discontinued)
DOD University Research Instrumentation Grants
AEC/DOE Specialized Facility Construction
AEC/DOE University Accelerator Acquisitions
DOE University Research Instrumentation Grant Program
DOE Used Energy-Related Equipment Program
USDA 1890 Research Facilities Program
USDA Agricultural Research Facilities Act

Institutional Support

NIH General Research Support Grants
NIH Biomedical Research Development Grants (Discontinued)
NIH Biomedical Research Support Grants NIH Biomedical Research Support Grants—Shared Instrumentation
NIH Health Sciences Advancement Award Program (Centers of Excellence) (Discontinued)
NIH Minority Biomedical Research Support Grants
NSF Research Improvement at Minority Institutions
NSF Science Development Grants (Centers of Excellence Program) (Discontinued)
NSF Institutional Grants for Science (Discontinued)
NASA Sustaining Universities Program (Discontinued)
DOD University Research Initiative
DOD Project Themis (Discontinued)
DOE University Institutional Research Grants (Discontinued)
USDA Hatch Act Formula Grants
USDA Cooperative Forestry Research Grants (McIntire-Stennis Act)
USDA Evans-Allen Payments to 1890 Colleges and Tuskegee University
USDA Animal Health and Disease Research Grants

Appendix IX

Definitions of Funding Categories

This appendix defines funding categories used in Federal Support trend data from 1963 to 1982 and correlates them to the six funding mechanisms we developed in this report.

Federal Support Definitions

Research and development includes all research activities, both basic and applied, and all development activities that are supported at universities and colleges. "Research" is defined as systematic study directed toward fuller scientific knowledge or understanding of the subject studied.

[This category corresponds to our category, direct support of research, which contains three funding mechanisms, namely individual project support, program support, and center support.]

R&D plant (R&D facilities and fixed equipment) includes all costs—direct and related—of all projects whose main objective is to provide support for the construction, acquisition, renovation, modification, repair, or rental of facilities, land, works, or equipment for use in scientific or engineering research and development. A facility is interpreted broadly to be any physical resource important to the conduct of research and development.

[This category is included within our funding mechanism, major equipment and facilities, which is not limited to fixed equipment.]

Facilities for Scientific/Engineering (S/E) Instruction in the sciences, engineering includes all programs whose main purpose is to provide support for the construction, acquisition, renovation, modification, repair, or rent of facilities, land, works, or equipment for use in instruction in science and engineering.

[The scope of this report does not include science education. Therefore, it is not included in our trend data except when it was part of another category and could not be identified separately. Until 1971, for example, it was included in the category for "Other S/E Activities."]

Fellowships, traineeships, and training grants include graduate programs in support of the development and maintenance of S/E personnel resources. The total amounts pertaining to such awards (stipends and cost-of-education allowances) are reported on the basis of the institution chosen by the recipient.

[This category corresponds to our funding mechanism, special training needs, in the category of research infrastructure.]

General support for science/engineering includes programs that support nonspecific or generalized purposes related to scientific research and education. Such projects are generally oriented toward academic departments, institutes, or institutions as a whole, and embody varying types of support ranging from support provided without any specification of purpose other than that the funds be used for scientific projects, to projects that provide funds for activities within a specified field of science/engineering without a specific purpose. NIH's Biomedical Sciences Support Grants and General Research Support Grants, and NSF's Institutional Grants for Science are examples of these types of programs.

[This category corresponds to our funding mechanism, institutional support, in the category research infrastructure.]

Other S/E activities include all academic S/E activities that cannot meaningfully be assigned to one of the preceding five categories. Types of activities included are those for which obligations are in support of technical conferences, teacher institutes, and activities aimed at increasing the scientific knowledge of precollege and undergraduate students.

[Although the scope of our report does not include these types of activities, prior to fiscal year 1966, this category contained data on training, and prior to fiscal year 1971, it contained data on "General" S/E activities. Thus it is necessary to include this category in chapter III of our report in order to analyze trends from 1963 to 1982.]

Non-S/E activities include all other obligations excluded from the six foregoing categories but that represent direct funding (excluding loans) from an agency to an academic institution for activities or purposes not specifically related to science and engineering. Included are all obligations for research, education, and facilities in the arts and humanities, as well as generalized projects for which the proportion utilized for S/E activities is unknown.

[This area is not covered in our report.]

Appendix X

Advance Comments From the Department of Health and Human Services

DEPARTMENT OF HEALTH & HUMAN SERVICES

Office of Inspector General

Washington D.C. 20201

JAN 17

Mr. Richard L. Fogel
Director, Human Resources
Division
United States General
Accounting Office
Washington, D.C. 20548

Dear Mr. Fogel:

The Secretary has asked me to respond to your draft report, "Federal Funding Mechanisms In Support Of University Research."

Department officials have reviewed this report with interest and have no comments to make, other than technical comments which have been separately provided to your staff.

Thank you for the opportunity to respond to your report before its publication.

Sincerely yours,

Richard P. Kusserow
Inspector General

PHS COMMENTS ON THE GENERAL ACCOUNTING OFFICE (GAO)
DRAFT REPORT "FEDERAL FUNDING MECHANISMS IN
SUPPORT OF UNIVERSITY RESEARCH"
DATED DECEMBER 19, 1985

The General Accounting Office (GAO) report is an informative document on the ways in which the Federal Government provides funding to U.S. colleges and universities in support of basic research. It should prove to be a valuable resource to those interested in obtaining a better understanding of the ways in which this support is accomplished.

General Comments

--The report does not discuss the distinction between assistance (grants and cooperative agreements) and acquisition (contracts) award instruments. Although all are used to fund university research, they differ at least in theory, with respect to the nature of the funding relationships and the mutual obligations between the research sponsor and the performer of the award.

--Although the discussion in the body of the report indicates that the research infrastructure is supported by all six funding mechanisms, the executive summary barely acknowledges this fact. The casual reader may draw the conclusion that on[illegible] ree funding mechanisms support the research infrastructure, [illegible] ally in light of figure 3.2 and the associated text indicating [illegible] creasing percentage of Federal obligations to support the infrastructure for the period 1963 - 1982.

Technical Comments

--Figure 1.2, Page 9

A footnote to the figure should indicate that this includes only the top six Federal agencies providing most of the support for scientific research.

--Table 2.8: Indirect Costs Across Funding Mechanisms, Page 37

Footnote R" should preferably read: "Reimbursement is provided through indirect costs of up to 8 percent of total allowable direct costs, or through a cost-of-education allowance."

--<u>Special Training Needs, Page 38</u>

The third sentence of this paragraph incorrectly states that NIH "does not include a cost-of-education allowance, but does reimburse the university for up to 8 percent of the direct costs of educating a student." In fact, the majority of NIH National Research Service Awards (NRSA) provide for the reimbursement of indirect costs at 8 percent of direct costs, and also allow for the payment of cost-of-education allowances. A small number of NRSAs do not pay for indirect costs but permit the payment of cost-of-education allowances, i.e., trainee tuition and fees plus funds for training related expenses only.

--<u>Major Equipment, Page 38</u>

The paragraph states in part that "NIH awards funds solely for the purchase of equipment and does not allow reimbursement of indirect costs." The paragraph should be amended to indicate that such procedure is not unusual since equipment purchases are very often excluded from the direct cost base used in the reimbursement of indirect costs.

--<u>Cost Sharing, Pages 38 and 39</u>

It states that Public Health Service awards require cost sharing. That was true at the time GAO conducted its review, but the cost sharing requirement, which has been in effect since 1966, was deleted from the Fiscal Year 1986 HHS Appropriations Act.

Reference is made on page 39 to cost sharing being established "by an institutional agreement made between NIH and the university . . . ." That should be corrected to read: ". . . by an institutional agreement made between HHS and the university that is on file and applies to all research awards made to that recipient. In cases where there is no institutional agreement, the cost sharing requirement is satisfied by a project-by-project agreement between NIH and the university."

--<u>Figure 3.1 (between pages 44-45) and Figure 3.2 (between pages 45-46)</u>

Figures 3.1 and 3.2 would be more technically correct if they indicated a discontinuity between the zero and first figures on the ordinate, i.e., vertical scale. This would be accomplished by placing a zero at the point where the vertical and horizontal axis meet and moving up the vertical axis with a jagged line to the first figure on the vertical scale.

--Award Review, Cost-Sharing, and Indirect Costs, Page 62

The third sentence of this paragraph states "None of the seven institutions (largest nonprofit givers to science research at universities among U.S. foundations and voluntary associations for Fiscal Year 1984) require cost sharing on their awards." This is an incorrect statement since a review of data on Tables 4.2, 4.3, and 4.4 on pages 59-61 indicates that the universities had to pay for the salary of the principal investigator or associated indirect costs. Cost sharing, whether implicit or explicit appears to be a reality by the U.S. foundations and associations referenced in the tables.

--Appendix I, Individual Project Support, Pages 75, 8 , 92, 93, 95, 101, 102, 103, 104, 148

A positive statement ("yes") is made about a cost sharing requirement, which has since been eliminated. Further, all the references on the pages cited speak only to an institutional agreement when, in fact, either a project-by-project or institutional agreement was permitted.

On page 75 under Other Significant Characteristics the word "primary" should be inserted in the first sentence so that it reads: "The grant is the primary instrument of choice for NIH." The words "and grants" should be inserted in the last sentence so that it reads: "Contracts and grants are used for [support of] clinical trials."

--Appendix I, Individual Project Support, Pages 86, 114, 115, 116, 117

Under Indirect Costs it inaccurately states: "Reimburse up to 8 percent of indirect costs" when instead it should state: "Reimburse up to 8 percent of total allowable direct costs."

--Appendix I, Individual Project Support, Page 89

On the first line, it states that NIH's Research Career Award program has been "Discontinued." That is incorrect. The word "Discontinued" should be qualified (as it is below under Time in Effect) to mean for new awardees since original awardees will continue to receive an annual salary allowance for the entire research career of the individual.

Finally, attached are various annotated report pages identifying corrections to NIH budget data appearing in the report.

GAO Comments

The following are GAO's comments on the Department of Health and Human Services' letter dated January 17, 1986.

1. All suggested changes have been incorporated into the text.

Appendix XI

Advance Comments From the National Science Foundation

NATIONAL SCIENCE FOUNDATION
WASHINGTON DC 20550

Division of Audit and Oversight

January 3, 1986

Mr. J. Dexter Peach
Director
Resources, Community, and
Economic Development Division
U. S. General Accounting Office
Washington, DC 20548

Dear Mr. Peach:

This is in response to your request of December 18, 1985 for comments on the draft GAO report entitled, "Federal Funding Mechanisms in Support of University Research."

The report is very well done and we have only a few comments.

While it is recognized that individual research projects provide support for equipment and graduate students, such grants also provide some support for infrastructure through indirect cost allowances for such items as use allowances or depreciation for buildings and equipment and for a portion of the top level administrative expenses.

In some places, for example in Chapter 3, some of the infrastructure support discussed, such as graduate student support, covers academic infrastructure generally, not just research infrastructure.

Several detailed clarifications are given in the enclosure to this letter. We appreciate the opportunity to comment on the report. If we can be of further assistance, please call me on 357-9457.

Sincerely yours,

Jerome H. Fregeau
Director
Division of Audit and Oversight

Enclosure

cc: Director
Deputy Director
Controller
Division Director, SRS
Division Director, DGC

Enclosure

Comments on Draft GAO Report,
"Federal Funding Mechanisms In
Support of University Research"

In the third paragraph on page 5, the first sentence could be read to imply that direct costs are not covered by reimbursements. This should be clarified.

The discussion of NSF policy on reimbursement of indirect costs for major facilities and equipment on pages 37 and 38 needs clarification to note that indirect costs are allowed only on installation and maintenance expenses, not on the purchase costs of the equipment. A similar clarification is needed on page 96. Since most indirect costs are reimbursed on the basis of direct-costs-less-major-equipment, this is a clarification for the reader but not a significant change.

On page 39, the statutory requirement for NSF is that there be some cost sharing on each award. The NSF interpretation of this requirement is that cost-sharing can be averaged over all awards to the institution with a minimum of 1% on each award. Average levels of cost-sharing are much higher. On page 76: Cost Sharing: Statutory cost sharing; averaged over institution with 1% minimum on each award. On page 85, a similar change for first $25,000. On page 91, the same. On page 106 and 107, add similar wording to each. I regret that the original NSF submission was not clear on this.

On page 45, the last line of the figure caption should refer to S&E obligations only, not to total obligations as implied.

Throughout the report, reference is made to "CASE data." Although convenient, this is not technically correct since CASE has not existed for a number of years. The correct reference is "Federal Support to Universities and Colleges."

GAO Comments

The following are GAO's comments on the National Science Foundation's leter dated January 3, 1986.

1. All suggested changes have been incorporated into the text.

Appendix XII

Advance Comments From the Department of Defense

THE UNDER SECRETARY OF DEFENSE

WASHINGTON DC 20301

RESEARCH AND ENGINEERING

8 FEB 1986

Mr. Frank C. Conohan
Director, National Security and
International Affairs Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Conahan:

This is the Department of Defense (DoD) response to the GAO letter of December 19, 1985 forwarding the GAO report (GAO Code 005713) titled, "Federal Funding Mechanisms In Support of University Research" (OSD Case 6899).

The DoD has reviewed the subject report and found it to be excellent. In particular, all statements relative to DoD are accurate and reflect the data the department provided in several conversations with GAO personnel.

The remainder of this letter simply elaborates on two points which, though included in the report, deserve additional emphasis:

1. At the time of our discussions, Congress was deliberating the initiation of a new research program at DoD and details on the "University Research Initiative," as the new program is called, were necessarily sketchy. Since then, the Congress has provided funding for the program and, though not completely finished, DoD is well along the way to establishing the operational mechanisms. Attachment 1 provides a short description of the program. Attachment 2 provides a chronology of events leading to the initiation of the program. Attachment 3 provides Congressional text applicable to the program.

2. As the report concludes, it is true that federal funding during the period 1963-1982 has increasingly involved supporting individual research projects with a concomitant decrease in support of the research infrastructure. However, it should be pointed out that DoD support of individual research projects does include support of the research infrastructure. For example:

   a. The budget for a typical individual project includes funds for capital equipment and, under current policies, title to the equipment is usually vested in the university.

b. Support of an individual project usually includes reimbursement of indirect costs. This can be viewed as a form of institutional support, particularly for fixed costs, as it provides a portion of costs that benefit the entire institution such as depreciation, research administration, library use, etc.

c. Finally, a considerable portion of the research under an individual project is typically performed by graduate assistants. Therefore, support of individual projects is an important source of funding for graduate students in science and engineering.

The DoD appreciates the opportunity to comment on the report in draft form.

Sincerely,

Donald A. Hicks

Attachments

THE UNIVERSITY RESEARCH INITIATIVE

The Department of Defense, through the Departments of the Army, Navy, Air Force, and the Defense Advanced Research Projects Agency, announces the FY 1986 University Research Initiative (URI).

URI is a multi-component effort designed to strengthen the capabilities of the universities to perform research and to educate scientific and engineering personnel in key disciplines important to the technologies that underly a strong national defense.

To meet mission-related needs, DoD relies on the universities to:

- conduct fundamental scientific and engineering research which supports Defense technologies;
- educate quality scientific and engineering personnel who perform research and who are employed in both industry and DoD;
- provide sound advice on technical issues related to national defense; and
- assist in transferring new technologies emerging from university research into industrial applications for both military and civilian uses.

DoD has an important stake in both the research produced by universities and the quality of the scientific and engineering personnel being educated in defense-related disciplines: one in six American scientists and engineers is engaged in defense work. The majority of these scientists and engineers -- almost a half million in all -- are involved in state-of-the art technologies that are not only crucial to defense mission accomplishment, but also are at the cutting edge of technologies essential to modern industry.

In recent years, however, it has become clear that declining investments in the university research and teaching base during the 1970's have resulted in deficiencies that hamper the ability of universities to produce quality research and education in scientific and engineering disciplines. Among these problems are a shortage of faculty qualified to teach certain state-of-the-art technologies; obsolete research instrumentation; and declining numbers of American citizens pursuing science and engineering graduate degrees. The components of URI focus on correcting these deficiencies.

URI was proposed in the President's FY 1986 budget submission to support quality research and education in science and engineering to meet the mutual needs of the DoD and the universities.

URI is designed to improve the quality of research performed at universities to meet defense needs; to strengthen multidisciplinary research which supports selected key defense technologies; to provide expanded opportunities for interactions between universities and the DoD research and engineering community, particularly the laboratories of the three Services; and to support fellowship and instrumentation awards in mission-related disciplines important to critical defense technologies. Each component of the URI program is described within this brochure. These components are designed to increase the number of science and engineering graduate students; to increase the investment in major pieces of research equipment at universities; to increase the investment in higher risk basic scientific research in support of critical defense technologies; and to provide more opportunities for contacts between universities, industry, and DoD laboratories to maximize the benefits to be derived from defense research for the nation's security, both military and economic. Because each component focuses on separate but complementary ways to meet the needs outlined above, each component necessarily has its own approach, application requirements, deadlines, and points-of-contact. This announcement provides a general description of the efforts and opportunities in meeting mutual science and technology goals of the DoD and the university community under the DoD University Research Initiative for FY 1986.

A DoD Steering Committee for the URI program has reviewed the DoD critical technology areas and has identified several technologies for special emphasis in URI; these technologies are listed in the following matrix and are described in the next section of this brochure. In addition, for each technology area, coordinating committees consisting of technical experts representing the Army, Navy, Air Force, DARPA, OSD and DoD laboratories will be established to coordinate the activities of the various components within each technology area. Finally each specific component will be managed by a lead service. The components of the URI are listed in the following matrix and are described in the last section of this brochure.

The URI program is brand new; it is expected to evolve rapidly in the next year or two as experience is gained with the program outlined herein.

CHRONOLOGY OF EVENTS
THE UNIVERSITY RESEARCH INITIATIVE

28 JAN 82 - Report of Defense Science Board Task Force on University Responsiveness to National Security Requirements.

Reports that universities are interested in contributing to the national defense needs but that they "require sustained Federal assistance to accomplish this, to replace obsolescent equipment, and to support graduate education of U.S. citizens by improved fellowship and educational support awards." Specifically calls for "increased 6.1 Research funding, apprenticeship programs, wider use of graduate fellowships and educational support awards, and the streamlining of contracting procedures."

16 APR 84 - Letter from USDRE to the President.

Discusses the erosion of the national support for education and research and the consequent impact upon the economy and defense; call for "a Presidential initiative to restore the United States' scientific and technological leadership position in the world."

09 AUG 84 - Letter from SECDEF to Secretaries of Military Departments, Chairman of JCS, Under Secretaries of Defense, etc.

Observes that DoD support for the tech base program has not met his expectations; calls for an eight percent annual real growth rate for both 6.1 and 6.2.

27 FEB 85 - Testimony of SECDEF before HAC on FY 85 Defense Posture.

Announces University Research Initiative (URI); describes initiative as including support for "areas of high risk, high payoff to DoD;" will feature "close collaboration between researchers in universities and DoD laboratories by providing for an exchange of highly qualified scientists and engineers between them;" will be used to "shore up the university infrastructure by expanding DoD's highly successful University Research Instrumentation Program, and by increasing the number of fellowships and research assistantships in disciplines of special importance to DoD."

01 MAR 85 - Memorandum from Acting USDRE (Wade) to Service Assistant Secretaries and DARPA Director.

Describes URI and its elements; encourages exchange scientist programs with DoD laboratories; calls for the establishment of a Tri-Service/DARPA committee to oversee interdisciplinary research programs.

07 MAR 85 - Testimony of Dr. Keyworth (OSTP) before HASC on URI.

Acknowledges key role played by universities in defense and civilian areas; supports the URI, calls for a higher level of funding than that requested in the DoD budget.

02 APR 85 - Testimony of DUSD(R&AT) on DoD Science and Technology Program before HASC.

Describes URI components. In first two years, emphasizes graduate fellowships, research assistantships, exchange scientists and instrumentation program, in later years emphasis shifts to high payoff research projects.

23-24 SEP 85 - Proposal on URI prepared by the three Services and DARPA and presented at the meeting of the DoD-University Forum Working Group on Science and Engineering Education.

Details three types of URI elements: personnel support (fellowships, exchange scientists), instrumentation support and multidisciplinary research centers/initiatives.

07 OCT 85 - DoD-University Forum meeting.

Forum adopts recommendations supporting URI presented by the university members of the Working Group on S&E Education.

23 OCT 85 - Memorandum for DUSD(R&AT) to Hobbs, Mooney and Paiewonsky on URI.

Calls for a coordination URI program which is distinct from the 61102 program; requests strong DoD laboratory involvement; directs a Steering Committee to provide oversight and calls for Coordinating Committees for each technology thrust.

CONGRESSIONAL TEXT APPLICABLE TO URI

House Committee on Armed Services, May 18, 1981

"In the case of university laboratories that carry out significant Department of Defense research, the committee believes that the Department of Defense should consider what part the Department of Defense can play in the effort to rehabilitate the university research base."

Senate Committee on Armed Services, April 13, 1982

"In short, the university research base in the United States is being dramatically weakened with grave implications for the national security. Consequently, the committee fully supports the proposed expansion of the Department's university research programs..."

Senate Committee on Armed Services; May 31, 1984

"The technology base programs represent our investment in future defense capabilities."

"DoD must do its share to maintain the excellence of our scientific infrastructure through strong support of university research."

House Committee on Armed Services; May 10, 1985

"The maintenance of an adequate technology base is a national priority with important economic as well as military implications. Accordingly, the need to ensure a viable technology base within the universities throughout the country is the responsibility of all Federal activities including the Department of Defense and the National Science Foundation."

Conference Committee, DoD Authorization Act of 1986; July 29, 1985

"The conferees strongly endorse the purpose of this initiative which includes providing fellowship aid in the scientific and technical disciplines, and modernizing the scientific and technical equipment and instrumentation at our universities."

House Appropriations Committee; October 24, 1985

"The committee is concerned about declining graduation rates for American scientists and engineers." ... "There is also a decline in the number of faculty members in the fields of science and engineering." ... "The universities are also experiencing shortages in state-of-the-art equipment and instrumentation... For this (sic) reason, the committee supports the University Research Initiative program as a means to determine and address the scope and impact of these problems."

Senate Appropriations Committee; November 6, 1985

"The committee recommends an appropriation of $75,000,000 for the University Research Initiative, an unbudgeted item. These funds will be used to expand university graduate fellowships in scientific and technical fields and modernize university laboratories and instrumentation."

GAO Comments

The following are GAO's comments on the Department of Defense's letter dated February 3, 1986.

1. All suggested changes have been incorporated into the text unless noted by further comments.

2. We discuss this program on pages 30 and 143.

3. We have generally emphasized throughout our report that DOD, as well as other agencies, supports the research infrastructure through research projects.

Appendix XIII

Advance Comments From the Department of Energy

Department of Energy
Washington, D.C. 20585

JAN 0 9 1986

Mr. J. Dexter Peach
Director, Resources, Community and
Economic Development Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

The Department of Energy (DOE) appreciates the opportunity to review and comment on the General Accounting Office (GAO) draft report entitled "Federal Funding Mechanisms in Support of University Research."

This draft report is a thorough and well-prepared summary of the various mechanisms used over time by the six major Federal R&D agencies to support university-based research and manpower development programs. Information in the draft report will be very useful to the Science Policy Task Force of the House Committee on Science and Technology in their analysis of Federal policies for the support of scientific and technical research. The report also will become an essential resource for current and future students as well as practitioners in science policy. Your staff are to be commended for their hard work in preparing this report.

DOE hopes that these comments will be helpful to GAO in their preparation of the final report.

Sincerely,

Martha O. Hesse
Assistant Secretary
Management and Administration

Department of Energy
Washington, D.C. 20585

JAN 09 1986

Mr. Mark Nadel
Resources, Community and Economic
Development Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Nadel:

In response to Mr. J. Dexter Peach's request of December 18, 1985, the Department of Energy's formal comments on the General Accounting Office (GAO) draft report entitled "Federal Funding Mechanisms in Support of University Research" are being submitted by separate letter to GAO.

Editorial comments on the report are enclosed for GAO's consideration in preparing the final report.

Sincerely,

Martha O. Hesse
Assistant Secretary
Management and Administration

Enclosure

Editorial Comments on the GAO Draft Report "Federal Funding Mechanisms in Support of University Research" (GAO/RCED-86-53).

1. page 4 - Executive Summary, 2nd paragraph - "For example, DOE uses research contracts to support groups of investigators performing research across disciplines in electronic sciences."

   Comment - DOE supports groups of investigators performing research across disciplines primarily in high energy and nuclear physics and in the materials sciences, not in electronic sciences

2. page 4 - line 11 - "accomplished" is misspelled.

3. page 11 - "DOE, however, specifically pointed out that its funding to universities includes more 'indirect' funding than direct. ...DOE obligated $550 million to university affiliated researchers working at government labs..."

   Comment - Most of this "indirect" funding goes to support the operation of research facilities and scientific instruments which are utilized by university scientists to conduct research. For example, 50% of the beam time at the Brookhaven High Flux Beam Reactor is used by university researchers. University scientists who use these facilities for their research should be more properly classified as "visiting scientists" rather than as "workers" at the labs.

2. page 35 - Table 2.7: This table notes that the award decision process for DOE-funded Research Centers and Major Facilities and Equipment is one of internal review only.

   Comment - The review procedures followed for projects of this type vary by project. Therefore, this table should note that "mixed" review procedures are used by DOE in these areas.

3. page 51 - "And DOE ended its (graduate) fellowship program in 1973."

   Comment - While DOE did end an agency-wide, generic graduate research fellowship program which encompassed a number of different scientific and engineering disciplines, individual DOE technology programs can support graduate fellowships where manpower statistics indicate there will be probable future shortages of advanced degree professionals. Approximately 60 graduate fellowships were supported in FY 1985 by individual DOE programs in such fields as nuclear engineering, health physics, fusion technology, etc. (See page 129 for details).

-2-

4. page 94 - Other Significant Characteristics: "--use of DOE laboratory facilities by university scientists (at the nine multiprogram labs, about 57% of the total operating time is used by university scientists)"

Comment - This statement should be clarified to note that 57% of the total operating time of "designated user research facilities at the labs" is used by university scientists. There are about 50 designated user research facilities in the DOE laboratory complex (see the Users Guide to DOE Facilities, DOE/ER-0174, for additional details on these various facilities).

5. page 112 - Other Significant Characteristics (Fossil Energy Centers)

Comment - A statement should be added that the Fossil Energy Centers may also compete for additional funding support from DOE along with other universities, the DOE laboratories and industry.

6. page 139 - Award Decision Process: Internal Review

Comment - The review process for the DOE University Research Instrumentation Program includes both peer review (through the use of special disciplinary review panels) and internal staff review. Accordingly, Table 2.7 on page 35 also needs to be changed. The "Major Facilities and Equipment" column for DOE should be changed from "I" to "Mixed".

7. page 140 - Number of Awards: 17

Comment - In FY 1985, 88 awards were made under this program, up from 20 awards in FY 1984.

8. page 140 - Other Significant Characteristics, line 4

Comment - Suggest hyphenation of "first-come-first-served"

9. page 157 - Evaluations: "A DOE evaluation of this program showed that for every dollar of institutional award received an additional five dollars was subsequently received from DOE or other sources for follow-on support."

Comment- This statement needs to be clarified. For every dollar DOE provided in the institutional research grant program, on average it was later determined that an additional five dollars was received by the university research group from other DOE programs and/or from a combination of state, private foundation or industrial support.

GAO Comments

The following are GAO's comments on the Department of Energy's letter dated January 9, 1986.

1. All suggested changes have been incorporated into the text.

Appendix XIV

Advance Comments From the National Aeronautics and Space Administration

NASA

National Aeronautics and
Space Administration

Washington, D C
20546

JAN 1 5 1986

Reply to Attn of: NIP

Mr. Frank C. Conahan
Director, National Security and
International Affairs Division
United States General Accounting Office
Washington, DC 20548

Dear Mr. Conahan:

Thank you for the opportunity to comment on the report on Federal Funding Mechanisms in Support of University Research (RCED-86-53).

I am sending you the comments of the NASA Chief Scientist which are the views of the agency. The comments will clarify or modify imprecise or incorrect statements in the draft report. These are presented in the enclosures to this letter.

Sincerely,

C. Robert Nysmith
Associate Administrator
for Management

Enclosure

NASA COMMENTS ON "FEDERAL FUNDING MECHANISMS IN SUPPORT OF UNIVERSITY RESEARCH"

The GAO report is quite informative. However, errors related to equipment, cost sharing, and instrument selection should be corrected.

The reference to NASA should be deleted from the major equipment section on page 38. NASA does not make awards solely for equipment, per se, as the text implies.

An error regarding cost sharing arises from a rather subtle situation which GAO has apparently misinterpreted. NASA has traditionally supported full reimbursement of costs and has opposed cost sharing on all types of award instruments. The HUD-Independent Offices Appropriations Acts for a number of years have carried a prohibition on full reimbursement of costs for research resulting from unsolicited proposals. However, exceptions on a case-by-case basis are permitted. Because of the limited application of the legislation to the kind of research activities sponsored by NASA, the use of cost sharing clauses in grants, cooperative agreements or contracts is minimal. However, it is NASA policy to use cost sharing where appropriate and the statement that there is "no cost sharing requirement" is misleading in suggesting that NASA is in violation of statute. There is no statutory or NASA FAR supplement requirement for cost sharing on university contracts.

The proper statement regarding NASA cost sharing is, "Governed by statute." Corrections are required on page 38, last paragraph; page 40, table; page 40, last paragraph; page 77; page 97; page 98; page 109; and page 110.

The "Other Significant Characteristics" section on page 77 purports to describe how NASA determines the support instrument. This description is not consistent with statute and, indeed, suggests some improper activity by NASA. The two sentences beginning with "According" should be deleted. If it is essential to describe instrument selection, then use: "Award instruments (contract, grant or cooperative agreement) are determined in accordance with P.L. 97-258 and OMB implementation thereof."

As NASA has taken rather strong positions on cost sharing, equipment awards and the "Chiles Act" (instrument usage) over the years, it is important that these corrections be made.

The section on Major Equipment and Facilities beginning on page 22 should be reworded. Specifically, the last sentence on page 24 should communicate that NASA has no "set aside" program for equipment. As it is, it implies we do no Facilities support. During Fy 84, $22 million dollars, ten percent of our university research grant money, went to facilities and/or equipment.

Table 2.5 on p. 27 is not accurate, as it reflects only one of three fellowship programs. The correction should be:

NASA

Graduate Student Fellowships	$ 1,800,000	120	$15,000
Faculty Fellowships	$ 2,412,121	275	$ 6,500
Post-doctoral Fellowships	$ 9,498,722	177	$53,665
SUBTOTAL	$13,710,843	572	

To accompany these figures, the two enclosures of program description should be inserted in appendix I, Special training needs after page 125.

The description of NASA'S award decision process on page 34 & the accompanying table 2.7 on page 35 (approximately 75% of total) are not accurate. NASA uses peer review on scientific projects and internal review on aeronautics and space technology projects (approximately 25% of total).

Frank B. McDonald
Chief Scientist

Enclosures

ENCLOSURE I

Special Training Needs

NASA Resident Research Associateships Postdoctoral and Senior Research Awards

PRIMARY OBJECTIVE: Awards to outstanding Scientists and engineers at the recent postdoctoral and experienced senior levels for tenure as guest investigators.

TIME IN EFFECT: 1959 - Present

FY 1984:

TOTAL FUNDING LEVEL: $9,498,722

NUMBER OF AWARDS: 177

AVERAGE AWARD SIZE: $53,665.00 (1st year)
AVERAGE DURATION OF AWARD: 2 years

AWARD DECISION PROCESS: Peer Review

COST-SHARING: No requirement

INDIRECT COSTS: N/A

OTHER SIGNIFICANT CHARACTERISTICS: Administered through The National Research Council

ENCLOSURE II

Special Training Needs

NASA Summer Faculty Fellowships

PRIMARY OBJECTIVE: Research Fellowships are awarded to engineering and science Faculty members for summer research in a NASA-University cooperative program.

TIME IN EFFECT: 1964 - Present

FY 1984:

TOTAL FUNDING LEVEL: $2,412,121

NUMBER OF AWARDS: 275

AVERAGE AWARD SIZE: $650 per week and travel allowance

AVERAGE DURATION OF AWARD: 10 weeks

AWARD DECISION PROCESS: Internal review

COST-SHARING: No Requirement

INDIRECT COSTS: Yes

OTHER SIGNIFICANT CHARACTERISTICS:

GAO Comments

The following are GAO's comments on the National Aeronautics and Space Administration's letter dated January 15, 1986.

1. All suggested changes have been incorporated into the text unless noted in further comments.

2. Faculty fellowships and postdoctoral fellowships mentioned here involve support for university scientists performing research at federal facilities rather than university-owned facilities. Because the scope of our report was limited to university facilities, we did not include these mechanisms in our report.

Appendix XV

Advance Comments From the Department of Agriculture

United States Department of Agriculture | Office of Grants and Program Systems | Office of the Administrator | Washington, D C 20250

JAN 28 1986

SUBJECT: GAO Draft Report RCED-86-53, Dated December 18, 1985, Entitled "Federal Funding Mechanisms In Support of University Research"

TO: J. Dexter Peach, Director
Resources, Community and Economic Development Division
U.S. General Accounting Office
Washington, D.C. 20548

THRU: Orville G. Bentley
Assistant Secretary for Science and Education

Peter C. Meyers
Assistant Secretary for Natural Resources and Environment

Steven Dewhurst
Director, Office of Budget and Program Analysis

The subject report has been reviewed with the following comments provided.

Page 24:
1980 Research Facilities sho[illegible] 1890 Research Fa[illegible]lities. This program includes instrumentation, construction or renovation, and land acquisition.

Page 29:
In the USDA portion, we recommend changing "1890 Colleges" to "Evans-Allen" to be consistent in reporting categories of programs rather than recipient institutions.

Page 38:
Cost Sharing
Cost sharing requirements at USDA depend upon statutory language rather than funding mechanisms. Most of the formula - funded programs in USDA for Research and Extension activities require matching from state and local sources on a dollar for dollar basis, however the states contribute far more than the required amounts for matching. On a nationwide basis, Federal dollars for Hatch Act and Smith-Lever Act programs accounted for 20-30 percent of the total Research and Extension programs conducted at land-grant universities in Fiscal Year 1985.

Page 81:
Primary Objective:
"...plant production..." should be changed to "plant science." The program encompasses more than production.

Page 130:
Cost-Sharing:
Cost sharing is not required as opposed to not allowed.

Page 141:
References to Tuskegee Institute should be changed to Tuskegee University.

Page 160:
References to Tuskegee Institute should be changed to Tuskegee University.

JOHN PATRICK JORDAN
Acting Administrator

GAO Comments

The following are GAO's comments on the Department of Agriculture's letter dated January 8, 1986.

1. All suggested changes have been incorporated into the text.

PART 2

ASSESSING FEDERAL FUNDING MECHANISMS

FOR UNIVERSITY RESEARCH

Executive Summary

Over 60 percent of university research funding comes from federal agencies. This research is a key element in the United States' international competitiveness and technology advancement. Other sources for research funding include industry, foundations, and state governments.

Approximately 71 percent of the federal research funds are provided through one funding mechanism or category of federal financial support for scientific research—individual project grants. Some scientists and policymakers have questioned the consequences of such heavy reliance on individual project grants. For example, does this mechanism discourage the performance of innovative, high-risk, and interdisciplinary research?

In response to the House Committee on Science and Technology's request that GAO assess the effects of different funding mechanisms on the productivity and performance of research, GAO looked at:

- Whether particular funding mechanisms played a role in helping universities improve program quality.
- Whether two funding mechanisms—individual project grants and center grants—had different effects on the performance of research.

In addition, GAO is providing the Committee with a separate report that describes the funding mechanisms used by federal agencies to support university research and trends in the use of such mechanisms.

Background

GAO looked at five universities that, according to surveys of the scientific community carried out by two education and research organizations, had reputed improvement in program quality. GAO concentrated primarily on what funding and other strategies these universities used to improve the selected departments and how the departments were able to finance their program improvement initiatives.

Two mechanisms for federal funding of university research are individual project grants and center grants. Individual project grants support individual researchers who do specific research. Center grants, which account for 9 percent of grants awarded, support broad coherent research programs and include coverage of facilities, equipment, and scientific and administrative personnel.

GAO assessed the merits of the two funding mechanisms against four factors that have the potential to affect the performance of research.

- Coverage of resource requirements, which includes trained technicians, equipment, and laboratory space.
- Stability of financial and resource support, which reflects the continuity and duration of support.
- Type of research supported, which includes the influence of funding availability on the flexibility to pursue new and different areas of research.
- Administrative burden, which includes researchers' time spent preparing proposals, overseeing grants, and reviewing proposals by others.

Results in Brief

The particular funding mechanism for university research played a lesser role in helping universities improve program quality than their ability to obtain grant funds from such sources as the federal government, state government, industry, and the university itself.

Responses of scientists to GAO's questions on coverage of resource requirements and administrative burden showed that these factors were less affected by the particular funding mechanism than by the field of science. On the other hand, scientists working under center grants responded that they had more stability of financial and resource support and that they were more likely to perform the types of research defined as innovative, high risk, or interdisciplinary than scientists working under individual project grants.

GAO's Analysis

Improving Research Quality

At the five universities GAO visited that were reputed to have improved program quality, the common element in improvement was an explicit commitment from the university to improve quality through increases in internal and/or external funding and personnel changes. Initial funding was necessary for building quality, although it came from a variety of sources. Two of the universities received National Science Foundation science development grants in the late 1960's that enabled them to bring in high-quality junior and senior faculty. Another university received state appropriations that were used to hire new faculty and increase the number and quality of postdoctoral fellows. Another university used funds from industrial sponsors to implement its plan for program improvement. (See chapter 2.)

Performance of Research

Coverage of resource requirements differed by field of science rather than by the type of funding mechanism (individual project or center grant). Fields of science differ in their needs for such resources as technicians, equipment, and laboratory space. For example, mathematicians working on theories may work in isolation with few assistants and little or no equipment. In contrast, cell biologists may need a number of lab assistants, and space scientists may invest large amounts of capital in equipment.

Scientists' concerns about stability of resources and financial environment differed depending on their field of science rather than on the funding mechanism. For example, award duration affects stability because award periods do not always match the actual time needed to perform research. Biochemistry projects may take less time to complete than genetic manipulation experiments in agriculture, where scientists must allow a complete new generation of crops to grow before testing can take place.

Scientists working under center grants reported that they were more likely to perform types of research defined by the National Science Foundation as innovative, high risk, or interdisciplinary than scientists receiving individual project grants. For example, 25 out of 32 scientists with center grants said they proposed research into new areas as opposed to 14 out of 33 scientists receiving individual grants. Scientists working under center grants believed they had more stability and resources to conduct these types of research.

Administrative burden, as measured by the amount of time spent in preaward activities (applying for awards) and postaward activities (responding to award requirements and reviewing proposals), varied more by field of science and agency requirements than by type of mechanism. Defense agency award requirements include postgrant reporting, while civilian agency award requirements include more preaward reviews of proposed research On the average, scientists in fields, such as artificial intelligence, that receive awards from defense agencies, reported they spent more time in postaward activities than in preaward activities. Scientists in fields, such as plant science, that receive awards from civilian agencies reported spending more time in preaward activities. (See chapter 3.)

Recommendations

GAO is making no recommendations.

Agency Comments

We did not request agency comments because our work was not carried out at any agencies and we do not have any adverse comments about any agencies or organizations. However, we requested comments on portions of the report from the five universities cited in chapter 2 as having improved program quality. Those comments are incorporated in this report.

Abbreviations

GAO	General Accounting Office
NIH	National Institutes of Health
NSF	National Science Foundation

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Chapter 1

Introduction

Since its inception in the late 1940's, the current U.S. system for scientific research has emphasized supporting individual scientists' research projects through national competition for awards. According to the National Academy of Sciences, the scientific community often associates the individual project award system with the success of U.S. basic research and views it as affording the greatest degree of opportunity for pursuit of meritorious ideas.

Despite the belief that the individual project mechanism is closely linked with U.S. success in basic research, the House Committee on Science and Technology has noted problems concerning the current funding system in which this award type predominates. This report, which was requested by the House Committee on Science and Technology, assesses the roles and impact of different kinds of support for university scientific research in different fields of science.

Among the problems with the current system noted by the Committee and others, such as the National Academy of Sciences, are:

- the increased volume of applications for research support that need to be reviewed;
- the tendency to fund traditional research ideas rather than innovative ones; and
- constraints in the provision of scientific research resources, such as equipment and personnel.

How the Current Funding System Supports Scientists

Scientific research in the universities depends heavily on the federal government. In fiscal year 1982 federal agencies provided 64 percent of the $7.3 billion spent at universities for research. The federal government supports university research through a variety of funding mechanisms. For purposes of this report, funding mechanisms are categories of federal-financial support for scientific research performed by U.S. universities; they can be divided into direct and indirect support.

Three funding mechanisms directly support research: the individual project mechanism, program support, and center support. Individual project awards are typically made to individual scientists for research that they have proposed in a discrete research area. This is by far the predominant mechanism, accounting for 71 percent of agency support. Program support provides support for more than one principal investigator in a broad coherent program of research, often multidisciplinary and long term. Center support provides funding for research projects that are coordinated into a coherent program in a broad field of interest at a university. The center award is the only mechanism that provides funding both for research and for equipment, facilities, and an administrative unit in the university. A recent illustration of the use of this funding mechanism is the National Science Foundation's (NSF's) establishment of engineering research centers, designed to strengthen this field by providing a concentration of facilities, personnel, and equipment.

Three other funding mechanisms indirectly support research by providing funds for "infrastructure." These funding mechanisms are training, equipment and facilities support, and institutional support for a university.

Objectives, Scope, and Methodology

The House Committee on Science and Technology requested that GAO assess the relative merits of different funding mechanisms in terms of their effects on the type of research being supported, research performance and productivity, agency procurement administration, management and administration by the performing organization, and from the point of view of the individual scientist. As a result of a literature review, the advice of a panel of experts, and consultations with the Committee, we agreed to assess funding mechanisms as they are used by recipients in different fields of science at specific research organizations. Our objectives in this assessment were

- to determine whether particular funding mechanisms play a role in helping universities improve program quality as perceived by the scientific community and
- to examine whether two different types of funding mechanisms—individual project grants and center grants—had different impacts on the performance of research.

Because almost no empirically based literature exists on funding mechanisms and their effects on research organizations, we adopted an exploratory approach to identify those issues that warrant further attention from policymakers. We conducted case studies at 15 different university research organizations. We used two sets of case studies, one focusing on reputed improvement in program quality, and the other on research performance and the perspective of individual scientists.

The Committee originally had included research productivity among the factors it requested we review. However, we determined that we could not precisely assess the effects of funding mechanisms on research quality and productivity because of current limitations in the techniques for measuring the outputs of research. Instead, in consultation with the Committee, we explored the linkages between the types of support flowing into research organizations and the reputed research quality of those programs.

We focused on how selected university departments were able to improve their research programs after the federal government had largely eliminated special financial assistance for program improvement in the early 1970's. We selected five universities that had successfully improved various departments over the past decade on the basis of two national surveys of U.S. research doctoral programs. The first ("A Rating of Graduate Programs") was conducted in 1969 by Kenneth D. Rouse and Charles J. Anderson for the American Council of Education, and the other ("An Assessment of Research Doctoral Programs in the United States") was conducted by the Conference Board of Associated Research Councils and published in 1982.

We used the following criteria to select the five universities after consulting with the study director of the 1982 survey.

- First, where did departments stand in terms of the 1982 survey's ranking of program quality improvement as based on responses from scientists in the same field around the country.
- Second, which departments showed the greatest change between 1969 and 1982 in program reputation, again based on scientists' assessments.

We visited the following universities and departments where we interviewed university administrators and faculty members and reviewed program improvement documentation and financial records. We looked at the role of funding mechanisms in the universities' program improvement strategies. Due to resource constraints, we focused on departments in one geographic region—the southeastern United States.

University	Department/School
Emory University	Department of Microbiology and Immunology
Georgia Institute of Technology	School of Chemical Engineering
University of Alabama in Birmingham	Department of Physiology and Biophysics
University of Texas at Austin	Department of Physics
University of Georgia	Department of Botany

Table 1.1: Universities With Reputed Improvement in Program Quality

To respond to the Committee's interest in the effects of different funding mechanisms on the performance of research, we designed our second set of case studies to explore further some of the problems cited with current federal support for university research. Time and resource constraints prevented us from assessing all six categories of funding mechanisms, but the approach we took still sheds light on issues endemic to all funding mechanisms. Our objective in this second set of cases was to examine whether two different types of funding mechanisms had different impacts on the performance of research. To meet this second objective, we studied two funding mechanisms, center funding and the individual project award mechanism, that together represent 80 percent of the federal dollars obligated for university research. We examined the impact of these two funding mechanisms by examining four factors related to the performance of research:

- coverage of research resource requirements, which includes trained technicians, equipment, and laboratory space;
- the stability of support, which reflects the continuity and duration of support;
- the type of research supported, which includes the influence of funding availability on the flexibility to pursue new and different areas of research; and
- administrative burden, which includes researchers' time spent preparing proposals, overseeing grants, and reviewing proposals by others.

The second set of cases was selected to allow us to examine the use of mechanisms historically, individually, and in combination at university research organizations. We chose a sample that matched two different types of research organizations (centers and departments), which we assumed would have different experiences with funding mechanisms. We defined centers as research organizations where research projects are coordinated into a coherent program in a broad field of interest at the university. Another defining characteristic of such organizations is core funding for equipment, facilities, and an administrative unit. We looked at centers that had received core funding from a government agency for at least 10 years and at departments that had received individual project awards in that same period of time.

Our sample of matched pairs cut across five fields of science. The final match of departments was made on the basis of location and the degrees to which the department matched the center in terms of types of research done and other factors, such as seniority of faculty members and coverage of distinctly different fields of science. The final sample is comprised of 10 of the 25 universities that received the most federal research and development support and represents a mix of public and private institutions.

Field of science	Center locations	Department locations
Mathematics	University of Wisconsin-Madison	University of Michigan
Space science	University of Chicago	University of Iowa
Artificial intelligence	Massachusetts Institute of Technology	University of Texas
Cell biology	Yale University	New York University
Plant sciences	Michigan State University	Cornell University

Table 1.2: Matched Pairs of Universities

In selecting different fields of science, we addressed the Committee's interest in the impact of different styles of support or combinations of funding mechanisms on various fields.

Our data collection efforts involved the administration of a structured questionnaire to principal investigators at the various universities. We also asked universities to provide us with data on their use of different funding mechanisms from federal and nonfederal sources in 1970, 1975, and 1984-85.

The questionnaire was administered to assistant, associate, and full professors at the universities we visited. In all we interviewed 70 research faculty. Using this questionnaire, we gathered data on a variety of factors bearing on the perceived impact of federal individual project grant awards versus federal center awards in terms of coverage of resources, stability, types of research, and administrative burden. These factors are discussed in detail in chapter 3.

In all cases, data were cross tabulated by type of research organization (department or center) and by field of science (artificial intelligence, space science, mathematics, cell biology and plant science). In addition, a series of open-ended questions were asked to develop additional information about the perceived effects of funding on scientific research. These questions were designed to create small-scale case studies when the comments of all scientists in a particular [illegible] department were aggregated.

Since the case study approach was used [illegible] th objectives, an important caveat must be noted. Our study is [illegible] representative of all fields of science, the totality of U.S. research universities, or all federal agencies or components of agencies.

We did not request agency comments because our work was not carried out at any agencies and we do not have any adverse comments about any agencies or organizations. However, we requested comments on portions of the report from the five universities cited in chapter 2 as having improved program quality. Those comments are incorporated in this report.

Chapter 2

Role of Funding Mechanisms in Improving the Quality of University Science

This chapter assesses the role of funding mechanisms in improving the perceived program quality of university science departments. In the 1960's federal agencies developed several funding mechanisms designed either to create new research expertise or to increase existing research expertise. These funding mechanisms had been discontinued by the early 1970's. In an effort to determine how selected university departments were able to improve their academic and research programs when the federal government had eliminated special financial assistance for research program improvement, we visited five universities that according to national surveys had successfully improved various departments over the past few years. (See objectives, scope, and methodology in chapter 1.) This chapter concentrates primarily on what funding and other strategies these universities used to improve the selected departments and how the departments were able to finance their program improvement initiatives.

We found that these departments financed program improvement plans by obtaining funds from federal grants, state government, industry, or university sources. With these funds the departments hired additional faculty, renovated research facilities, and purchased new equipment. These actions contributed to the quality of their research programs and enabled the departments to compete successfully for additional external grants and contracts. Although the departments used a variety of funding mechanisms, the individual project grant was the principal mechanism used by all the departments. Two departments received special science development grants from the National Science Foundation in the mid-1960's. Table 2.1 briefly summarizes the information we found concerning these funding mechanisms and program improvement strategies for these five departments. More detailed summaries follow the table.

University	Funding sources used to improve program	Federal research funds 1970	1984	Percent change	Key elements of improvement
Emory University, Microbiology and Immunology Department	University awarded $620,000 to department as seed money.	$ 140,466	$1,158,441	+725	Seed funding used to increase the number of tenured faculty members; new department chairman in 1979.
Georgia Institute of Technology, School of Chemical Engineering	Increase in support from industry, federal government, and foundations (industrial sponsors).	149,016	754,273	+406	1978 implementation of written plan for improvement of program. Plan focused on faculty recruitment and improving university relations with industry.
University of Alabama at Birmingham, Physiology and Biophysics Department	Seed money from state appropriations.	240,401	2,488,969	+935	New chairman in 1979; focus on hiring new faculty and increasing the number and quality of postdoctoral fellows.
University of Georgia, Botany Department	1967 NSF Science Development grant of $972,000 matched by an infusion of state funds and start-up funds from the university for new researchers. Individual research grant sustains program improvement; unrestricted income from an endowment fund.	405,695	1,673,874	+313	Support through a variety of funding mechanisms allowed expansion of space for faculty and student research and the addition of more faculty, equipment, graduate students, and postdoctoral fellows.
University of Texas at Austin, Physics Department	1966 NSF Science Development grant. Department strengthened by income from private endowment.	1,762,154	7,825,487	+344	Science Development Grant provided the opportunity to bring in high-quality junior and senior faculty with initial research support. University funding procedures enhanced acquisition of equipment, thereby improving program quality.

Table 2.1: Characteristics of Departments With Improved Program Quality

Emory University

The Chairman of the Microbiology and Immunology Department told us that the department began its greatest period of growth and improvement in 1979, when he was hired. The chairman described the department at that time as a modest, but decent one, which he believed could be expanded into a well-balanced, nationally recognized, high-quality department. The university's administration also wanted to improve the quality of the department and agreed to provide about $620,000 in "seed money" to increase the number of tenured faculty. Additional funds were provided to acquire more modern equipment for instructional and research purposes and to support additional graduate and postgraduate students. In addition, the university agreed to renovate space for the Microbiology and Immunology Department. According to the department chairman, renovation costs were between $1.5 million and $1.75 million.

The chairman told us that the first priority for improving the department was to hire additional faculty members who were highly trained, prominent in their field, and who would aggressively seek external research funds through grants and contracts. When the chairman was hired in 1979, the department had eight faculty members. Today, the department has 11 faculty members, 5 of whom have been hired since the new chairman came on board. The current faculty has successfully increased the department's external funding from about $240,000 in 1979 to over $1.5 million in 1985, including about $1.4 million in federal funds. The department would like to increase its faculty to 16 or 18 members, but current space constraints have precluded further growth.

Acquiring additional equipment for research and instructional purposes was another high priority for improving the department. A 1978 appraisal of the department's laboratories concluded that existing equipment was not suitable for modern research approaches in microbiology. Since then, the department has purchased several new pieces of equipment.

According to the department chairman, applicants for predoctoral and postdoctoral training in the department have also increased in number and quality. In 1979 the Microbiology and Immunology Department had only 5 graduate students; today it has 24. The department has provided financial support for six of the predoctoral and postdoctoral students through a training grant from the National Institutes of Health (NIH). This grant, which began in July 1984, will provide a total of $499,640 over a 5-year period. The university has also increased its student fellowship support for this department from $32,500 in 1979 to a 1985 level of $65,700 per year.

NIH's Biomedical Research Support Grant provides additional funds on the basis of total amount of NIH grant dollars received by Emory. The university then shares these funds with various departments as the need arises, or example, to purchase expensive pieces of research equipment or provide interim support for faculty who are "between research grants." Research funds from the Multiple Sclerosis Society, the American Cancer Society, the Rockefeller Foundation, and the state of Georgia provided about $150,000 in 1984, or about 11 percent of the department's external research funds. Because Emory is a private university, it does not receive an appropriation from the state of Georgia.

Georgia Institute of Technology

School of Chemical Engineering officials told us that substantial improvements that were made in the quality of its faculty, graduate students, and educational program would not have been possible without a flexible university administration, a determined newly appointed Chemical Engineering director, and a supportive faculty. In a time of decreasing federal support for program improvement, Chemical Engineering developed a comprehensive written plan for improving the quality of its program. The essence of its plan was to achieve excellence by improving the quality of its faculty and graduate students. Improving relations with industry was also a priority.

Since 1978 the Chemical Engineering School has successfully attracted 11 new faculty members. The Director of Chemical Engineering, in reflecting on the improvement in quality of the school, cited a number of factors responsible for the successful recruitment of highly qualified new faculty. The factors he cited were

- a perception that the rapidly changing Georgia Tech Chemical Engineering program would be a good place to build or continue a career,
- the willingness of the Dean of Engineering to permit the school to recruit faculty at all ranks, and
- attractiveness as a place to work and live.

Faculty recruitment took priority over building the Chemical Engineering graduate enrollment. The department established an initial goal of four to five graduate students per faculty member and carried out extensive recruiting efforts to achieve that goal. In the summer of 1978 Chemical Engineering had only 12 graduate students, today, it has about 100.

In addition to improving the quality of faculty and graduate students, improving communications and relationships with industry was also a priority of the school director. He believed a good relationship with industry not only enhances educational opportunities for the students, but also increases industry's financial support for the program and contributes to the institution's stature. Activities aimed at improving the school's external relationships, including industry, during the past few years included

- establishing external advisory boards comprised of industrial and academic representatives interested in the program,
- publishing a new graduate program booklet containing specific program information and listing the research interests of individual faculty,
- issuing an annual alumni newsletter since 1979, and
- pursuing opportunities for interaction with industrial representatives.

The budget for Chemical Engineering has increased dramatically during the past 15 years. In 1970 the budget was approximately $582,000, but by 1984 the budget had grown to more than $3.5 million. The greatest budget increases have occurred since 1978, the year the new director was hired.

The increase in funds has come from several sources including the state of Georgia, the federal government, and industry. Because the Chemical Engineering School performs extensive research, a substantial part of its funds come from grants and contracts from industry and government agencies. In 1970 the state of Georgia supplied 68 percent of its funds, with the remaining 32 percent provided by industry, the federal government, and foundations. By 1984, however, the trend was away from state support, with only 50 percent of the school's funds coming from the state. The remaining 50 percent of the $3.5 million budget came from such external sources as industry, the federal government, and foundations (including industrial sponsors).

University of Alabama in Birmingham

Much of the Physiology and Biophysics Department's improvement, as reported in the 1982 "Assessment of Research Doctoral Programs in the United States," has occurred since 1979 when a new chairman was hired. According to the department chairman, the goal of the university's administration and departmental faculty was to accelerate the modest expansion that had taken place in previous years and generally to broaden the scope of research in the department. The department emphasized recruiting new faculty, consolidating the faculty into a single functional unit, purchasing new scientific and word processing equipment, restructuring the graduate program, and starting a series of departmental seminars featuring nationally recognized speakers from other universities. Of these stated goals, the chairman told us that the department has been most successful in improving the quality of its faculty and increasing the number and quality of its postdoctoral fellows. University officials attributed much of the department's improvement to a supportive and flexible university administration, a substantial increase in state funding, and the strong leadership of the new department chairman. A substantial increase in external funds also helped finance the program improvement initiatives.

The department chairman, in reflecting on the improvement in quality of the department, stated that his number one priority upon arriving was to build a strong research program. He believed this could be achieved by hiring the best possible researchers in their respective fields. Because of the university's willingness to hire faculty at all ranks and to pay highly competitive salaries to get them, the department has been successful in attracting 10 researchers since 1979. The chairman described these researchers as outstanding and as having international stature in their research field. These faculty members have aggressively sought external research funds that have helped to support the program improvement plans.

Funding for the department has grown dramatically over the last 10 years. In 1975, for example, the total departmental budget was only $464,880. It had grown to $1.7 million in 1980, but by 1985, the budget had increased to more than $5.5 million. Department officials estimated that individual project grants make up at least 90 percent of awards in their department, and that the ability to compete successfully for external research money is one key to the program's success. Most of the increased funding has come from additional federal money for research, but substantial increases also occurred in funds from state appropriations and from nonfederal health agencies such as the American Heart Association, the American Cancer Society, and the Cystic Fibrosis Research Center. According to University officials, "seed money" from the university's state appropriation helped start the program improvement initiatives.

The Physiology and Biophysics Department Chairman told us that the department has also been successful in attracting outstanding graduate and postgraduate students. The most impressive growth has been in the number of postdoctoral fellows. In 1979, for instance, the department had only seven postdoctoral fellows. By 1984 that number had grown to 22, compared with a national average of 6 in a typical physiology department.

University of Georgia

University officials cited several factors that have been responsible for the improvement in the Botany Department.

- The university was committed to developing an excellent department.
- In 1967 the university received a $6.0 million NSF Science Development Grant. The Botany Department's share of the grant was $972,000. These funds and a commitment of funds from the state government enabled the department to increase the faculty size from 15 to more than 20 and to purchase new equipment.
- The state provided over $3.4 million to build a new 157,000 square foot plant sciences building and allocated to the Botany Department 60,000 square feet for teaching and research facilities. The new space assisted in the recruitment of desired faculty specialists, and shared space promoted interdepartmental cooperation and communication. Part of the cost of this new building ($500,000) came from an NSF Science Development Grant.
- The university provides start-up funds for new researchers. Depending on the area of research, start-up costs range from $15,000 to $100,000 per researcher. For example, it costs about $100,000 to set up a plant molecular biologist with the necessary laboratory facilities and equipment to compete for external funding.
- Strong leadership from the university administration and Botany Department faculty promoted and encouraged research, which attracted external research funds. Federal research funds, for example, grew from $41,000 in 1965 to almost $1.7 million in 1984.
- In more recent years, income from a $1-million endowment fund, designated solely for the Botany Department, has also provided substantial unrestricted money that the department can use for special needs such as research equipment, student assistance, and travel.

Along with the improvement in faculty, research equipment and facilities, the department chairman believes the quality of graduate students has also improved. Currently, the Botany Department has about 50 graduate students, about 30 of whom receive teaching assistantships and 20 of whom have grant funds.

Although NSF's Science Development Grant served as a catalyst for program improvement, university officials believe that the individual research grant has been the major funding mechanism that has sustained the program improvement momentum. They believe a department needs start-up or "seed money" to attract high-quality faculty and provide necessary research space and equipment, but after that, the individual research grant is the mechanism for achieving the highest quality science research.

The Botany Department has experienced remarkable growth in funding. Federal funding has grown from $41,000 in 1965, to $405,000 in 1970 (includes part of the NSF Science Development Grant) to almost $1.7 million in 1984. Total department funds from the state and federal governments, industry and foundations, and endowment income grew from $1.7 million in 1980 to more than $3.0 million in 1984. Most of this growth has been in federal research funds through individual research grants.

University of Texas at Austin

According to the Physics Department Chairman, since receiving an NSF Science Development Grant in 1963, the department has made progress in improving the quality and number of faculty and graduate students and in improving its overall research program. Funds provided by the grant were used for (1) additional faculty, (2) initiation of new research activities, (3) establishment of a Faculty Associate Program whereby recent doctoral recipients were brought to campus for 2-year periods of introduction to teaching and research, an (4) initiation of a program of curriculum development. University administrators stated that a major positive effect of the NSF Science Development Grant was the opportunity it provided for bringing in high-quality junior and senior faculty with initial research support at a time when few universities could provide such funding. The Physics Department had 25 faculty members in 1965 but, with this grant, the faculty grew to 40 by 1968. The department has continued to grow and currently has a faculty of 65, including 2 Nobel laureates and 5 members of the National Academy of Sciences.

In addition to improving the quality of the faculty, the quality and number of the graduate students has also improved. According to present and former department chairmen, graduate enrollment has increased from 100 in 1965 to over 250 in 1985. In addition, postdoctoral fellows have increased from none in 1965 to over 100 in 1985.

Expenditures for the Physics Department have increased from $1.9 million in 1970 to $10.8 million in 1984. Income from private endowment has greatly strengthened the department financially. At the time of our visit, the department had six endowed chairs at $1 million each, six endowed professorships at $100,000 each, and one lectureship. In addition, the University of Texas System has an endowment valued at about $2 billion. Income from the endowment is about $150 million per year with two-thirds going to the University of Texas System and one-third going to the Texas A&M System. With this endowment income, the universities pay off bond obligations, finance construction projects, and provide funds for overall program improvement at the schools.

One important feature of the University of Texas at Austin's funding procedures is that the university matches federal grant funds designated for equipment. For example, if a researcher in the Physics Department receives a $100,000 federal grant that includes $20,000 for equipment, the university will provide matching funds for the equipment part of the grant. A university official told us this matching procedure is a very effective method of improving the department's research program.

As mentioned earlier, the Physics Department Chairman told us that the NSF Science Development Grant awarded in 1966 was a major factor in the overall improvement of Texas' Physics Department. However, when we discussed with university officials the success of this grant, they cautioned us about the widespread use of this type of funding mechanism. School officials told us that the success of development grants depends greatly on proper planning for the use of the funds. For example, if the funds are used to increase the number of faculty in the department, the university must be able to absorb these faculty costs whenever the grant funds are discontinued. Otherwise, the university might have to reduce its faculty and the school would be back where it was in the beginning, before the grant funds.

Summary

In the development of productive university research organizations, funding mechanisms play different roles at different stages. The common element that was reported to us in improvement at the universities we visited was an explicit commitment from the university to improve its program and to do so through increases in internal and external funding and personnel changes.

Seed funding from either government or private sources was reportedly a prerequisite to program improvement in all of the departments we visited. Two of the five departments we visited received substantial NSF Science Development grants in the late 1960's. University officials at both schools agreed that the availability of these federal grants was a major factor in their program improvement strategy and enabled each department to attract excellent researchers, renovate research space, and purchase critical equipment. Although the other three departments did not receive science development grants, they were able to obtain financial support from the university, state government, and industry.

After the investment of seed money in the departments we visited, faculty members competed successfully in their fields, and the primary source of support became the individual project mechanism. These moneys, along with supplemental support from state government, endowments, industry, or university funds, can generally sustain the quality program, at least in the short run. In the departments we visited, the universities' commitment to absorb the increased faculty costs when the science development grant or other seed money ended, helped sustain the high-quality programs and allowed the departments time to secure adequate external funding to make them predominantly self-supporting. The seed money was thus "leveraged" to obtain a broader base of support.

Chapter 3

Role of Funding Mechanisms in the Performance of Research

The House Science and Technology Committee requested that we assess the relative merit of different funding mechanisms in terms of their effects on the productivity and performance of research. While the previous chapter focused on factors affecting the improvement of program quality, this chapter examines the impact of two different funding mechanisms on the performance of research. We compared five departments that rely primarily on the funding mechanism of individual project grants with five centers that rely primarily on the funding mechanism of center support. For each department or center, we examined four key factors that had the potential to affect the performance of research—coverage of research requirements, stability of financial and resource support, the influence of funding mechanisms on the flexibility to pursue new and different categories of research, and administrative burden. (See objectives, scope, and methodology in chapter 1.) While our primary focus was to identify the impact of two funding mechanisms on these key factors influencing the performance of research, the case study approach also provided insights into other influences on the performance of research.

We found that particular funding mechanisms, such as individual project awards, do not by themselves have consistent advantages or disadvantages for the performance of university research. With few exceptions, no clear-cut differences emerged between the experience of center- and department-based scientists with federal support. The nature of the funding and the extent of resource coverage depend upon many factors, such as differences between agencies, university policies, and varying resource needs. We also found that:

- Distinctions between individual project awards and center funding are blurred by scientists' strategies to increase their ability to perform research, for example, grant applications to multiple sources.
- Certain characteristics of the individual project award mechanism result in some problems, for example, discontinuous funding for graduate students.
- Issues specific to each field of science, as well as certain characteristics of funding mechanisms, can impede the performance of research.

The remainder of this chapter highlights findings from our analysis of the impact of funding mechanisms and other influences on four key factors with the potential to affect research performance.

Appendix I summarizes the responses of all scientists to selected questions.

Coverage of Resource Requirements

The performance of research requires continued coverage of resource requirements. Scientists need trained technicians, equipment, and space to conduct laboratory experiments and other research. Fields of science differ in their resource requirements, depending on the stage of each field's development and its technological requirements. For example, mathematicians working on "pure" theory may work in isolation with few assistants and little or no equipment. In contrast, cell biologists told us they may utilize a number of lab assistants, while space scientists told us they may need large amounts of capital for equipment. In such labor- or capital-intensive fields, interruptions or delays in access to resources can slow research progress or force dissolution of established research teams and laboratories.

We found that while certain funding mechanisms provided more continuous access to resources, the design of specific mechanisms seemed to have less effect on the performance of research than the total volume of funding available for different fields of science and fluctuations in that funding. The responses of scientists regarding their ability to acquire needed resources clustered more by fields of science than by experience with particular funding mechanisms.

The lack of variation in responses from scientists receiving support from center or individual project awards to cover resource requirements might be accounted for by a number of other issues mentioned by the scientists we interviewed. The coverage of resource requirements reflects interactions between an agency's decisions resulting from its review process and policies and an individual scientist's definition of resource needs for a specific project in a given field of science. Resource coverage may be influenced by

- the degree of variation among types of support, even within a single funding mechanism category;
- differences in agency review processes;
- agency policy decisions, such as use of funds to cover equipment or graduate education;
- the extent to which universities supplement resources;
- the types of research undertaken, as well as the scale of research efforts;
- individual scientists' perceptions of the extent to which their funding requests will be approved; and
- scientists' informal knowledge of what criteria govern decisions made by agency officials or groups of scientific reviewers.

These interactions can be better understood in the context of three resource coverage areas we examined: facilities, equipment, and human resources.

Facilities and Equipment

Experience with individual project or center awards did not appear to be the significant factor in affecting scientists' responses to questions concerning adequacy of equipment and facilities. Instead, perceptions of problems in these areas differed by field of science.

Overall, 28 of 36 researchers who had been in the federal award system since 1970 said that the quality of facilities for their research had increased or stayed the same. Scientists in two fields—plant sciences and artificial intelligence—did not report decreases in quality of facilities since 1970. Scientists reporting decreases were in cell biology, mathematics, and space science.

		Figures in percentage			
		Increased	Same	Decreased	
Has the quality of facilities changed since 1970?	Center	42.9	21.4	35.7	n=14*
	Department	54.5	31 8	13 6	n=22

*"n" here and through the text indicates number of scientists who responded to the question

Table 3.1: Facilities

Differences among fields of science were also seen in equipment coverage. Although scientists in all fields, with the exception of mathematicians, expressed concern over equipment, space scientists showed the most concern (8 of 11). They told us that much of their equipment is 20 years old and is maintained periodically by scientists and technicians In addition, as table 3.2 shows, over half of the scientists stated that needed equipment is difficult to obtain. There are no clear-cut differences in the experiences of center and department scientists in the ease or difficulty in obtaining equipment.

		Figures in percentage		
		Agreed	Disagreed	
The equipment I need is very difficult to obtain under current programs.	Center	54.5	45 5	n=22
	Department	53.3	46.7	n=30

Table 3.2: Equipment

Human Resources

The funding mechanisms we looked at were not the most significant factor influencing responses by scientists to our questions about coverage of such human resources as technicians and graduate students. Problems with funding for technicians cut across a number of fields of science—cell biology, plant science, artificial intelligence, and space science. Scientists attributed problems with hiring and retaining technicians to factors other than funding mechanisms, such as industrial competition and current salary structures for technicians at different universities.

Table 3.3 indicates that both center and department scientists view this as a problem. Center scientists felt more difficulties with the availability of technicians, although both center and department scientists reported difficulties in supporting technicians.

		Figures in percentage			
		Increased	Same	Decreased	
Has the availability of technicians changed since 1970?	Center	10.0	30 0	60 0	n=10
	Department	18 2	54.5	27.3	n=11
			Agreed	Disagreed	
It is difficult to support technicians needed.	Center		76.2	23.8	n=21
	Department		86.4	13 6	n=22

Problems cited by scientists relating to funding coverage for graduate students touched on a number of interrelated issues concerning university goals and funding mechanisms available for supporting these goals. We found variations in the types of personnel supported by university research groups. For example, some centers have a clearly defined training function, while others support research and not graduate education. In addition, we found that some problems associated with support for graduate students could be traced to the type of funding mechanism used. Scientists across all fields (58 of 66) agreed that project support should not be used to support graduate students as is the current practice. The negative effects they cited included the disruption caused for graduate students by the loss of support from individual project awards. They suggested the establishment of separate mechanisms for graduate student support.

Table 3.3: Technicians

Stability of Financial and Resource Support

A relatively stable resource and financial environment is generally considered beneficial for the conduct of science. Particularly in resource-intensive areas and ones where teams of researchers must be assembled, the predictability of continued funding is important. The stability of support depends not only on the continuity of funding, but also on its duration through a project's cycle. To determine the impact of funding mechanisms and other factors on the stability of support, we examined: the cyclical nature of support, lengthy gaps between periods of funding, and appropriateness of award duration for the research being performed.

The Cyclical Nature of Support

We found that while center support provided more continuous access to resources, the total volume of funding available for different fields of science and fluctuations in that funding seemed to have more of an effect on the performance of research than the design of specific mechanisms. Both center and department scientists we surveyed told us they have had their federal funding cut (table 3.4). Scientists recognized the cyclical nature of federal support for different topics of research. Scientists also recognized the increased opportunities to compete for private support in areas of commercial potential and industry interest, such as artificial intelligence and plant biology in agriculture.

		Figures in Percentage		
		Yes	No	
Have you ever had your project funding cut?	Center	77.4	22.6	n=31
	Department	83 3	16 7	n=36

Table 3.4: Funding Cuts

Scientists in fields of shifting program priorities can also be affected by the cyclical nature of support. For example, NSF's attempt to ensure stability at the field of science level in mathematics by dividing available funds for the mathematics subfields, such as complex analysis, resulted in destabilizing research environments for certain other subfields and individuals. This example shows that the effects of funding mechanisms on university research cannot be assessed without consideration of contextual factors such as agency policies.

The influence of factors other than funding mechanisms on the stability of the support can be seen in fields of science dependent on NIH funding. The Office of Management and Budget proposed cutting the number of NIH awards from 6,529 in fiscal year 1985 to 5,000 new and continuing awards in fiscal year 1986 and further to use the savings from that reduction to spread the available funds by distributing the awards over 2 or more years instead of 1 year. Scientists in cell biology, one of the fields supported by NIH, told us they were concerned with the politicization of federal funding for research (e.g., we heard comments such as "non-scientific events at the federal level," "arbitrary OMB decisions," and that fluctuations "depend on the Administration"). Their perceptions of instability are indicated by the contrast between their success in obtaining funding and an increased sense of unpredictability (table 3.5).

		Figures in Percentage			
		Increased	Same	Decreased	
How has the predictability of obtaining federal project funding changed?	Center	23.1	15.4	61.5	n=13
	Department	27.3	27.3	45.5	n=22
How has your success rate in funding changed?	Center	10.0	80.0	10.0	n=10
	Department	11.1	66.7	22.2	n=18

Table 3.5: Changes Over the Last 15 Years in Areas Affecting Research Performance

Funding Gaps

We found that the type of funding mechanism used had a more significant impact in the area of funding gaps than in other areas related to stability. For departmental scientists who received individual project awards, rather than center funding, funding gaps sometimes translated into ending support that broke up research teams and caused the loss of trained professional technicians. Scientists noted that the social and economic costs of funding gaps (human suffering, retooling, increased time expended by scientists in the day-to-day operations of the lab) were an intangible cost in the performance of research.

In contrast, we found that the center mechanism provided a measure of flexibility that enhanced the stability of the research environment for those scientists who received center support. Scientists cited the informal sharing of resources possible under center funding as one contributing factor to stability of funding. Center funding provides some seed money to start research that would otherwise be unfunded and bridges periods when noncenter funds are terminated. Finally, it can provide for more continuous support of professional technicians. Funding gaps in the centers were seen as delays in funding, rather than as an end to support.

Although center support provided more stability in funding, we found that some department scientists had developed strategies that seemed to compensate for funding gaps. To prevent an abrupt stop to their research, scientists will apply to multiple sponsors in order to guarantee the continuity of their work. When one project ends, the researcher is still receiving support from other sources. A second device is the practice of working as a co-investigator on someone else's award. To meet equipment needs, scientists in one department we visited collaborated and were able to pool resources from various project awards in order to establish equipment for common use.

		Figures in Percentage		
		Yes	No	
Have funding gaps been a problem?	Center	27.6	72.4	n=29
	Department	50.0	50.0	n=34

Table 3.6: Funding Gaps

Award Duration

Scientists receiving both types of mechanisms expressed concern about award duration (table 3.7). However, scientists in most of the centers we studied commented that they had a longer term commitment under the center mechanism than scientists who received individual project awards. Award duration affects stability because award periods do not always match the actual time needed to perform research, which can vary even within a field. For example, one scientist told us that biochemistry projects take considerably less time to complete than genetic manipulation experiments in agriculture, where scientists must allow a complete regeneration of crops before testing can take place. Scientists also suggested that for many fields, shorter duration awards (less than 2 years) did not recognize start-up time as a legitimate facet of research and thus did not permit the following of coherent research strategies. Finally, scientists recognized the difference between the long-term way in which they perceive research (scientists conceptualized their work as life long, or in terms like "a 50-year project") and the relatively short-term way in which funding agencies perceive research (in 3-to 5-year increments).

		Figures in Percentage		
		Agreed	Disagreed	
Award periods are too short to finish a project within one award cycle.	Center	59.3	40.7	n=27
	Department	61.8	38 2	n=34
There's not enough time to complete scholarly articles during the project award period.	Center	45.2	54.8	n=31
	Department	54.5	45.5	n=33

Table 3.7: Experience With Federal Awards

Types of Research

Some differences in the types of research supported emerged between the two mechanisms studied. One criticism of the individual project award review system is that it does not adequately support innovative, high-risk research. A task force of the National Science Foundation

Advisory Council identified the following three classes of innovative, high-risk proposals: research that challenges currently accepted scientific hypotheses; interdisciplinary proposals or research that transfers knowledge from one scientific field to another; and research that is at the edge of technical feasibility. To determine which mechanisms (centers or individual project awards) more often support innovative, high-risk, and interdisciplinary research, we asked scientists a series of questions about their research.

We found that more scientists in centers are likely to perform the types of research defined as innovative, high risk, or interdisciplinary. More center than departmental scientists:

- performed research bridging two or more fields (30 of 32 center scientists versus 21 of 36 departmental scientists);
- proposed research into new areas (25 of 32 center scientists versus 14 of 33 departmental scientists); and
- proposed work with industrial applications (9 of 32 center scientists versus 3 of 33 departmental scientists).

Although innovative, high-risk, and interdisciplinary research tended to be performed by scientists in centers, in certain cases the field of science, not the affiliation with a center or department, seemed to influence the types of research performed. For example, all plant scientists in the center and department (11 of 11) described their research as interdisciplinary, bridging two or more fields. Differences were not clear cut between scientists who proposed new technical processes with support from the center or individual project awards. Few mathematicians had proposed new technical processes (3 of 20) or proposed research into new areas (7 of 13). In contrast, almost all plant scientists (10 of 11) and scientists in artificial intelligence (8 of 9) had proposed research in new areas.

Administrative Burden

One aspect of the current reliance on the individual project award system that has been criticized by scientists is the time and expense of preparing and administering a large volume of applications. Time spent by scientists in preparing and reviewing research proposals is seen as resulting in a decline of research productivity. Discussion has also suggested a need to streamline procedures for administering grants and contracts, without reference to the particular funding mechanism involved.

The time commitment by scientists required to participate in the federal funding system can be divided into two categories: preaward and postaward. This time encompasses not only proposal applications, but also responses to sponsoring agencies' requests for proposal review, participation in technical monitoring, and the preparation of status and final work reports.

We examined the relative amount of time spent in award-related activities by scientists receiving center support and those departmental scientists receiving support from individual project awards. We were also interested in whether scientists perceived differences in administrative burden between sponsors. We also asked university administrators to comment on these issues.

We found that, for the scientists we interviewed, the amount of time spent applying for awards, responding to award requirements, and reviewing proposals varied not by type of mechanism but more by the field of science and the requirements of the dominant agency sponsoring research in each field. We also found that no single issue emerged among these 70 scientists regarding the presence of administrative burden. Scientists' perceptions of difficulties in this area can be shaped by a number of factors: whether individuals or groups submit multiple applications in order to obtain federal awards, the number of researchers in relationship to available funding, and changes in agency requirements. We found that scientists at the schools we visited tended to cite a number of problems when specifically asked about administrative burden, ranging from the time spent in responding to regulations imposed by different governmental bodies to time and effort reporting.

Table 3.8 lists differences among fields for the 10 schools we visited in the amount of time spent in activities. Differences result from variation in agency requirements for funding research rather than from the type of mechanism employed. The major distinctions among fields seemed to be in the area of preaward and postaward requirements. Scientists receiving funding from the Department of Defense, the National Aeronautics and Space Administration, and the Department of Energy (agencies that make decisions internally or through combined internal and external review) might spend less time on proposal review, one example of a preaward requirement, than scientists supported by NSF and NIH. NSF and NIH use only one form of decision making, peer review, a process designed to have groups of scientists to review the merits of work proposed by colleagues in various specialties. In contrast, researchers in artificial intelligence spent more time responding to the requirements of technical monitors, a postaward requirement common in research

	Writing applications weeks/year	Proposal review days/year	Status reports days/year	Technical monitoring days/year	Noncompetitive renewal days/year
FIELD OF SCIENCE					
Plant science	5.6 n=10	18.5 n=11	6.3 n=11	3.6 n=10	3.7 n=9
Cell biology	4.7 n=12	15.5 n=10	5.4 n=14	3.1 n=14	1.1 n=14
Mathematics	2.0 n=20	5.9 n=20	2.6 n=18	.8 n=16	1.9 n=14
Space science	3.5 n=11	7.7 n=12	4.1 n=11	1.2 n=11	3.5 n=11
Artificial intelligence	3.9 n=10	9.7 n=10	6.6 n=9	6.4 n=9	1.9 n=9
All scientists	3.6 n=63	10.6 n=63	4.7 n=63	2.7 n=60	2.3 n=57

Table 3.8: Average Time Spent by Scientists in Award-Related Activities

funded by the Department of Defense. Three scientists in artificial intelligence, a field that re‸ 'ves support from both civilian and defense agencies, perceived NSF to be the most burdensome in preaward requirements and least demanding in postaward requirements compared to defense agencies.

While there were no clear-cut differences overall in the administrative requirements, we found that some centers are designed in such a way as to insulate staff from the burden of administrative tasks. For example, at one university the center director had a small core staff to handle the writing of proposals and other award-related tasks.

One postaward issue we specifically addressed concerned the ease or difficulty in shifting funds between expenditure categories (table 3.9). We asked researchers whether they found it difficult to shift funds between categories. We wanted to know whether they had the flexibility to shift resources in the event of unexpected events such as a change in the direction of their research. This did not seem to be a clear-cut issue for center investigators, who split on their responses to this question. In contrast, more department scientists (25 of 34) found it easier to shift funds. Certain restrictions seem to lead some researchers to resort to other sources of funding rather than attempt to acquire approval for such expenses as travel or equipment. However, several researchers praised NIH and NSF, agencies that have decentralized administrative responsibility for overseeing shifts in expenditures to the university level. We also found examples of unique forms of the individual project award that are flexible in character, such as general research contracts from the National Aeronautics and Space Administration and the Office of Naval Research.

General research contracts have broad objectives and provide the principal investigator with considerable discretion in how the funds are used. Among other uses of these contracts, the principal investigator can support young investigators who have not established a performance record or technicians and graduate students during funding gaps.

		Figures in Percentage		
		Agreed	Disagreed	
It is difficult to shift funds between expenditure categories.	Center	50.0	50.0	n=22
	Department	26.5	73.5	n=34

Table 3.9: Shifting Funds

For university administrators, three factors affect the amount of time spent in administering federal research awards. Administrative time can be increased by institutional policies for review, differences in the process of negotiating and administering contracts with different sponsors, and difficulties with specific legal instruments rather than funding mechanisms.

Summary

Our case studies of the role of different funding mechanisms in enhancing or inhibiting research performance show that particular funding mechanisms we looked at do not always have consistent advantages or disadvantages in the performance of research. Performance of research can be affected by any of the following factors: resource coverage, stability, the flexibility to pursue new research ideas, and administrative burden. For these factors, we found issues that were either funding mechanism-related, field of science-related, or cut across funding mechanisms and fields of science.

In looking at the issues that relate to specific funding mechanisms, the center grants we examined were somewhat more likely to provide more continuous access to resources; to afford a greater degree of stability for the performance of research; and to enhance the performance of innovative, high-risk, or interdisciplinary research.

Field of science-related issues included the following. the cyclical nature of support for the field, changes in agency relationships, and the unique needs of subfields. The cyclical nature of support for different fields seemed to explain differences in resource coverage between fields. Differences among fields of science were seen in coverage of resources—facilities and equipment. For example, scientists in organizations receiving a relatively rapid increase in volume of funding, such as artificial intelligence and plant biology, said that the quality of facilities for their research had increased or stayed the same. Space scientists, working in a field with stable or decreasing funding, showed more concern over the condition of their facilities and equipment. Cell biology is a field of science that illustrates the effects of a change in agency relationships. In this field, which is primarily supported by NIH, scientists we interviewed described the destabilizing of their research environment caused by executive branch decisions to change the number of awards made by NIH for individual project support. The unique needs of subfields can also affect scientists' experience with funding mechanisms. For example, the time needed to perform research can vary even within a field as in the case of plant biology in which it may take several years for a new crop to grow and be tested.

Issues that cut across mechanisms and fields of science include the current problem of finding and keeping technicians. Similarly, perceptions of administrative burden seemed influenced by factors other than mechanisms and characteristics of a field of science. Problems were attributed to a range of factors, including university procurement policies and state and municipal regulations.

Appendix I

Summary of All Scientists' Responses to Selected Questions

Figures in Percentage

Stability of Financial and Resource Support	
Has the success rate in funding of federal proposals over the last 15 years changed? (n=28)	
Increased	17.9
Same	71.4
Decreased	10.7
Award periods are too short to finish a project within one award cycle. (n=61)	
Agreed	60.7
Disagreed	39 3
There is not enough time to complete scholarly articles during the project award period. (n=64)	
Agreed	50 0
Disagreed	50.0
Have you had problems because of gaps in your funding? (n=63)	
Yes	39.7
No	60 3
Has the predictability of obtaining federal project funding changed over the last 15 years? (n=35)	
Increased	25.7
Same	22.9
Decreased	51 4
Have you ever had your project funding cut? (n=67)	
Yes	80.6
No	19 4
Coverage of Resource Requirements	
Has the quality of facilities changed since 1970? (n=36)	
Increased	22.2
Same	27.8
Decreased	50 0
The equipment I need is very difficult to obtain under current federal award program (n=52)	
Agreed	53 8
Disagreed	46.1
Has the availability of technicians changed since 1970? (n=21)	
Increased	14.3
Same	42.9
Decreased	42.9
It is difficult to support technicians needed. (n=43)	
Agreed	81.4
Disagreed	18 6
Types of Research	
Some projects are not funded because they don't fit conventional areas favored by reviewers. (n= 55)	
Agreed	41.8
Disagreed	58 2
Administrative Burden	
It is difficult to shift funds between expenditure categories. (n=56)	
Agreed	35.7
Disagreed	64.3

"n" indicates the number of scientists who responded to the question.