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ABSTRACT

This report, prepared by the United States General Accounting Office, focuses on the forecasting of science and engineering personnel in the 1980's and the use of the information in policy formation. The General Accounting Office recommends steps to be taken by the Office of Science and Technology Policy in evaluating the effects of major federal programs on scientists and engineers. The shortage of opportunities for young faculty researchers in the 1980's is recognized and factors needing further investigation are identified. (Author/SA)

REPORT BY THE U.S.

General Accounting Office

Science And Engineering Manpower Forecasting: Its Use In Policymaking

The manpower pool of scientists and engineers constitutes an invaluable national resource. Government programs and policies greatly influence their utilization. Manpower statistics and forecasts are important as the Government monitors the scientific and technological enterprise, but policymakers must understand their limitations. GAO recommends steps for the Office of Science and Technology Policy to take in evaluating the implications for scientists and engineers of major Federal programs.

GAO also identifies factors needing further exploration as the Government considers a current manpower issue the perceived shortage of opportunities for young faculty researchers in the 1980s.

PSAD-79-75
JUNE 27, 1979

UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

IN REPLY REFER TO:

PROGRAM ANALYSIS DIVISION

B-133183

To the Director, Office of Science and Technology Policy and to the Director, National Science Foundation

This report presents our views on the Federal role in maintaining the proper balance between the supply and utilization of scientific and technical manpower. Our assessment of a current science manpower issue--the perceived shortage of opportunities for young faculty researchers--is also addressed.

The report contains recommendations to you on pages 17 and 30. As you know, section 236 of the Legislative Reorganization Act of 1970 requires the head of a Federal agency to submit a written statement on actions taken on our recommendations to the Senate Committee on Governmental Affairs and the House Committee on Government Operations not later than 60 days after the date of the report and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

Copies are being sent to the Director of the Office of Management and Budget, the committees of the Congress mentioned above, and to the Senate Committees on Commerce, Science, and Transportation and Human Resources and the House Committees on Science and Technology and Education and Labor.

H S Havens

Harry S. Havens
Director

GENERAL ACCOUNTING OFFICE
REPORT TO THE DIRECTOR, OFFICE OF
SCIENCE AND TECHNOLOGY POLICY

SCIENCE AND ENGINEERING
MANPOWER FORECASTING:
ITS USE IN POLICYMAKING

D I G E S T

Recognizing the social impact of science and technology, the Congress declared the manpower pool of scientists, engineers, and technicians an invaluable national resource to be as fully utilized as possible. The Federal Government influences the supply and utilization of scientists and engineers directly through actions such as grants, contracts, and Federal employment and indirectly through Government policies and regulations affecting the national economy. (See p. 1.)

THE FEDERAL ROLE

GAO examined the evolving Federal role, the Government's current monitoring of science and engineering manpower resources, and the potential for developing an improved forecasting capability to effectively utilize the Nation's scientists and engineers. (See p. 5.)

Government programs and policies greatly influenced the "boom and bust" cycles of the science and engineering labor market occurring over the past several decades. Studies showed that:

--Necessarily quick Government responses to external threats or shifts in domestic priorities caused large-scale fluctuations in demand for manpower, including highly trained manpower.

--The inherent flexibility of the economy could not always be relied on to assure a balance between supply and demand.

Studies of the changing manpower demands of the 1960s and 1970s concluded that the Government should

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--follow a long-term strategy to provide continuity in funding scientific research,

--avoid or minimize sudden shifts which could result in scientific manpower shortfalls or erosion of research capability,

--improve manpower forecasting, and

--establish better mechanisms for assessing and coordinating manpower implications of Federal policies. (See p. 8.)

Currently, the Office of Science and Technology Policy and the National Science Foundation monitor the scientific and technological enterprise, including science and engineering manpower, for Government-wide trends, implications, and problems. (See p. 9.) Improvements have been made in the data used to assess the Federal impact on science manpower. (See p. 11.)

MANPOWER FORECASTING--USEFUL BUT INEXACT

Forecasts of the projected needs and utilization of scientists and engineers, and the effects of Federal actions on the labor market are useful tools in formulating policy. Improved forecasts and the new science policy structure have reduced the likelihood of future imbalances happening without alerting policymakers. However, the limits of their uses must be recognized. (See p. 12.)

The cost and benefit of even further refinements in forecasting should be evaluated before initiation (see p. 14), as they will not preclude imbalances from happening because:

--Unpredictable events may happen.

--National policy may change dramatically due to changing needs.

--The Government does not control the supply of scientists and engineers in a free labor market.

--The response to change of those in a free labor market is hard to predict. (See p. 16.)

The Government's influence on the scientific and engineering labor market is great, but its predictions of the future and the marketplace performance are imprecise. Therefore, it is desirable that a focal point in the executive branch establish clearly defined long-term goals, make analyses of the potential benefits and risks of alternative policies, decide whether or not Federal action is warranted, and evaluate scenarios of possible outcomes of alternative plans. (See p. 17.)

GAO recommends that the Director of the Office of Science and Technology Policy and the Director of the National Science Foundation improve evaluation of the implications of major Federal actions for scientists and engineers by

--including an overall assessment of the Federal impact on scientists and engineers as part of the annual and 5-year reports on science and technology, thus providing appropriate visibility and distribution, and

--including more users on the National Science Foundation's newly formed panel on manpower information to get better advice on user's science and engineering manpower informational needs. (See p. 17.)

PROSPECTIVE LOSS OF YOUNG SCIENTISTS IN ACADEMIC RESEARCH

GAO examined the Government's various roles in a current scientific manpower issue--the perceived shortage of job opportunities for young scientists aspiring to go into research in the Nation's universities.

Projections for the 1980s show a leveling of college enrollments and a limited number of vacancies for young scientists as new junior faculty, because incumbents are not of retirement age and hold tenured positions. (See p. 18.) Reports show a declining trend in young science faculty at the universities where most of the Nation's basic research is performed. The science community believes that the infusion of new ideas from young faculty is essential to the health of basic science. (See p. 19.)

GAO found that Federal officials have developed an increasing awareness of the issue's complexity and the need to put it into sharper focus. They have begun to analyze its causes and some possible solutions. As Federal monitoring and evaluating continues, GAO believes that certain factors should be fully explored and critically examined. (See p. 27.)

Some forecasters and policymakers have cited the decline, but have not stated what the percentage or number of young scientists for the 1980s should be. Recognizing that making such quantitative estimates is difficult, GAO believes that, unless the current declining trend is compared to a standard, a change but not necessarily a problem is indicated. (See p. 21.)

Some question remains as to whether the projected outlook for young faculty openings at all colleges and universities represents those colleges and universities where most basic research is done. Also, variances exist among various academic disciplines in the reported downward trend of young faculty. The trends of other critical factors affecting the number of openings for young scientists on faculties--faculty deaths and retirements, faculty mobility, and student enrollment rates--remain uncertain. (See p. 24.)

In addition to these factors, future action will have to consider the degree to which universities themselves can, should, or will mitigate the declining trend and the effectiveness of past actions, such as increased funding for basic research. (See p. 28.)

RECOMMENDATIONS

GAO recommends that, in bringing the scarcity of opportunities for young research scientists into sharper focus, the Director of the Office of Science and Technology Policy and the Director of the National Science Foundation

--assess the seriousness of this issue and characterize, as definitely as possible, the flow of young scientists desired and needed to insure the future strength and creativity of American science;

--describe the current situation and future flow likely to occur without Federal action; and

--evaluate and propose Federal initiatives as needed. (See p. 30.)

Contents

ABBREVIATIONS

GAO	General Accounting Office
NSF	National Science Foundation
OSTP	Office of Science and Technology Policy
Ph. D.	doctor of philosophy

CHAPTER 1

INTRODUCTION

Recognizing the social impact of science and technology, the Congress declared the manpower pool of scientists, engineers, and technicians an invaluable national resource to be as fully utilized as possible. National policy should include a continuous appraisal of the roles science and technology play in achieving goals and formulating policies, including the recruitment; education; training; and beneficial use of adequate numbers of scientists, engineers, and technologists. 1/

The Government influences the supply and utilization of scientists and engineers directly through actions such as grants, contracts, fellowships, and Federal employment and indirectly through Government policies and regulations affecting the national economy.

Through the National Science Foundation (NSF) the Government compiles data on the availability and projected need for science manpower to provide a source of information for policy formulation by the Federal agencies.

The Office of Science and Technology Policy (OSTP) was established by the Congress in 1976 to serve as a scientific and technological analysis and judgment source for the President on major Federal policies, plans, and programs. Among many duties, the Director of OSTP was charged with encouraging development and maintaining an adequate data base, including forecasts of future manpower requirements and assessing the impact of major governmental and public programs on manpower resources.

PAST CONCERNS

Over the past several decades, the science and engineering labor market has been greatly affected by Government policies and programs. The reaction to Russia's Sputnik, for one, resulted in a national goal of reaching the moon. After the moon landing, national objectives shifted away from aerospace and defense, lessening the demand for scientists and

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1/National Science and Technology Policy, Organization, and Priorities Act of 1976 (Public Law 94-282, May 11, 1976).

engineers. Because of the time required to educate them, the supply trails behind the market's demand. Therefore, their numbers continued to increase after demand decreased.

According to a 1972 report of the President, such quick responses to external threats or shifts in domestic priorities have been responsible for large-scale fluctuations in manpower demands, including scientific and other professional workers. 1/

Concern about these "boom and bust" cycles in the science and engineering labor market focused attention on the role of the Government. The President's study concluded that to prevent shifts in funding scientific research programs, the Government should be guided by a long-term strategy. According to the report, a major challenge for the Government was establishing better mechanisms for assessing and coordinating the manpower implications of its policies in all major fields.

CURRENT ISSUE

National science leaders, including the Directors of OSTP and NSF, have expressed concern about the declining number of university faculty positions that will be available to young scientists during the next decade. Because most basic research is performed in colleges and universities, a continued flow of young researchers is considered essential for the health of American science by maintaining a flow of innovative ideas. Manpower analyses are being used to evaluate this perceived problem.

PURPOSE OF REPORT

Analyzers of the consequences of Federal actions on manpower have noted the need for coordination and long-term planning. In establishing OSTP, the Congress saw a need to strengthen the system for forecasting scientific and technical manpower utilization. This review was undertaken to

--determine the Government's past and present roles in the science and engineering labor market;

--examine the Federal data gathering function and its use in decisions affecting scientists and engineers, particularly in balancing the supply with utilization;

1/"Manpower Report of the President," March 1972.

--analyze the Government's consideration of the reported lack of opportunities for young researchers; and

--determine the executive branch's mechanisms for maximizing manpower utilization in fulfilling its role as science manpower policymaker.

OUR PRIOR REPORTS

One of our previous reports, "Long-Range Analysis Activities in Seven Federal Agencies," (PAD-77-18, Dec. 3, 1976), discussed criteria for performing effective long-range analysis. Although this report did not specifically discuss manpower analysis, we believe these criteria apply: specify broad long-term policy objectives, consider alternative policies, set priorities among policies, lay out alternative plans, evaluate the consequences of alternative plans, and coordinate the study and disseminate the results. This report concluded that the most important factor in assuring the existence of high-quality, long-range analysis is the presence of a customer who wants it and will use it.

Another of our reports, "Reemployment Assistance for Engineers, Scientists, and Technicians Unemployed Because of Aerospace and Defense Cutbacks", (Department of Labor, B-133182, Dec. 5, 1973), discussed the effectiveness of the Federal program designed to help reemploy unemployed scientists and engineers.

SCOPE

Our review of Federal involvement in the scientific and technical labor market included (1) interviewing science and engineering manpower experts at Federal agencies, private organizations, universities, and private research institutes involved in the development and use of manpower data bases and forecasts, (2) reviewing the available literature on scientific and technical manpower data bases and projections, and (3) obtaining background information and published data on scientific and technical manpower from both public and private organizations, including NSF, OSTP, the National Academy of Sciences, Veterans Administration, Department of Energy, and the Department of Labor.

We considered the opinions, both published and unpublished, of many manpower analysts. However, conclusions and observations reflect our independent evaluation of the available data and analysis. We did not test the accuracy of the numerous data bases or analyses used.

We discussed our report with OSTP and NSF officials and incorporated their comments where appropriate.

CHAPTER 2

THE FEDERAL ROLE IN THE SCIENCE AND ENGINEERING LABOR MARKET-- PLANNING FOR UTILIZING PEOPLE AND MEETING NEEDS

The Government is a major influence on the science and engineering labor market through its various roles, as a direct or indirect employer or supporter; as a decision maker as to which policies and programs are to receive or lose Federal support; as the gatherer, publisher, and interpreter of manpower data to be used by Government, academia, industry, and the general public in manpower decisions; and as monitor and coordinator of the results of these often unrelated actions to determine if some counterbalancing measures are called for.

We examined the evolving Federal role in the labor market during the past several decades. The Government's involvement in the boom and bust employment cycle of scientists and engineers has been the subject of considerable study, offering the benefit of lessons learned from the experiences and a yardstick for measuring the Government's current monitoring structure. We also examined the possible development of an improved forecasting capability to more fully utilize the Nation's scientists and engineers.

Also, the limits and prerequisites for Federal actions have been illustrated by using a current scientific manpower issue--the perceived shortage of opportunities for young faculty researchers. (See ch. 3.)

PAST PATTERNS OF SCIENCE AND ENGINEERING EMPLOYMENT

Influence of Federal support

The demand for scientists and engineers, like other production factors, is derived from the needs of private and public consumers. In expressing national needs, the Government has created a demand for scientists and engineers by its substantial support of research and development and its purchase of goods and services.

In 1975 the Government directly employed 14 percent of the doctorate-level scientists and engineers, and in 1976 sponsored over 50 percent of the Nation's total research and development. Thus, the Government's direct sponsorship of the Nation's research and development, coupled with its purchasing power, is so significant that a change in the amount or purpose of funds can alter the employment of scientists and engineers. Large and rapid changes in Federal support have been cited as a cause of boom and bust in their employment patterns.

Measured in current dollars, Federal research and development expenditures grew from $8.8 billion in 1960 to $19.6 billion in 1976, increasing every year except 1969 and 1970 when they dipped $31 million and $127 million, respectively, from the prior year's level. This continued rise in Federal support is not reflected, however, when measured in constant 1972 dollars. Growth occurred between 1960 ($12.7 billion) and 1967 ($18.2 billion), then declined about 20 percent by 1974 ($14.5 billion). Similarly measured, Federal support for basic research declined about 10 percent from 1968 ($2.9 billion) to 1972 ($2.6 billion).

Other contributing factors

Although increases in Federal funding for research and development contributed to making the 1960s a golden age of science and technology, other conditions also fostered the growth of science and engineering. These conditions included a strong and expanding economy, technological advances, the post-World War II baby boom, an increase in the percentage of students seeking advanced degrees, and increased Federal student support.

When national priorities shifted in the late 1960s and early 1970s, the scientific and technical labor market experienced increased unemployment, and a short-run imbalance between supply and demand. At the same time, economic activity slowed as the Nation moved from a defense/war-related economy. Also, the labor market was beginning to feel the effects of demographics--the baby boom generation was reaching employment age.

Effects on employment

The science and engineering labor market demonstrated flexibility in adjusting to the disruptions of the 1960s and 1970s. In total numbers, employment of scientists and engineers increased steadily between 1950 and 1974. However, while employment was increasing, so was unemployment. The table below, developed from data in NSF's "Science Indicators," shows the changes in the unemployment rate for scientists and engineers between 1966 and 1974 relative to the total labor force.

Unemployment Rate
for Selected Years

Year	Total labor force	Professional and technical	Scientists	Engineers
	(percent)			
1966	3.9	1.3	.4	.7
1968	3.6	1.2	.9	.7
1970	5.0	2.0	1.6	2.2
1971	6.0	3.0	2.6	2.9
1974	5.6	2.3	.9	1.3

The significance of these changes can be interpreted differently. On the one hand, the unemployment rate reported for scientists and engineers increased more rapidly than that of the total labor force between 1968 and 1971. On the other hand, it never exceeded 3 percent. The Director of OSTP wrote that the question of whether scientists and engineers had undergone a traumatic employment fluctuation over the last 20 years must be viewed in broader context. He also wrote that scientists and engineers have basically been among the most employed members of our society.

Economic slump effects on individuals

Although the science and engineering labor market was flexible enough to keep overall unemployment low, there was disruption and dissatisfaction for some individuals. The starting salaries and the number and type of job offers received by some new workers did not meet their expectations, causing them to question the value of their additional education and training.

Some individuals were likely to have found employment in nonscience and engineering fields and others in jobs underutilizing their training. However, assessing underemployment is difficult. Preliminary results from an NSF-sponsored study indicate that many Ph. Ds., who may be considered underutilized because they have jobs not usually associated with that degree, may earn at least as much money and be as satisfied as Ph. Ds. in the more traditional jobs of teaching and research.

FEDERAL MONITORING OF SCIENCE AND ENGINEERING MANPOWER

The Federal role in science and technology policy, priorities, and planning has been studied and debated throughout the years.

Although the science and engineering labor market responds and adjusts to changing demands and conditions, manpower experts have found a need for the Government to monitor the adequacy of this flexibility. One manpower analyst concluded that the 1970-72 turmoil

> "* * * could have been much greater except for the inherent flexibility of the economy. Substantial as this flexibility is, it dare not be relied upon to assure a balance in the demand and supply for trained manpower."

He went on to note that, at that time, there was no organization, in or out of the Government, with clear responsibility to monitor these events. He suggested developing a long-term policy for Federal support of science and higher education and consideration in budget formulation of the manpower implications of initiating, expanding, reducing, or eliminating large military and civilian programs. 1/

The President's 1972 Manpower Report examined the Government's manpower policy and the manpower issues related to the professions and higher education. On the basis of experiences in the previous decade, the report confirmed that the Government, forced to respond quickly to external threats or shifts in domestic priorities, had been directly and indirectly responsible for large-scale fluctuations in the demand for manpower.

The report also noted that support for the Federal research and educational effort was distributed among a number of departments and agencies. Also, the monitoring of the prospective changes in the demand and supply of professional and technical manpower had never been effectively centralized.

1/Eli Ginzberg, The Manpower Connection--Education and Work, 1975.

According to the report, to the extent consistent with other national objectives, Federal funding of scientific research should be guided by a long-run strategy. This strategy would protect the training capabilities of major educational institutions and maintain a competent scientific cadre and a broad-based research structure. At least, the strategy should avoid or minimize sudden shifts which could result in later shortfalls in science manpower or the erosion of the research capability required for national defense and social and economic progress.

The report concluded that to coordinate Federal programs from the viewpoint of their manpower consequences was a major challenge. The Government could improve its manpower planning and achieve a more effective policy by establishing better mechanisms for assessing and coordinating the manpower implications of its policies in all major fields. Although the report considered the impact of Federal programs on all manpower, its major thrusts, such as the impacts of changes in Federal funding, either specifically addressed or were logically applicable to science and engineering personnel.

ACTIONS TO STRENGTHEN FEDERAL PLANNING AND MONITORING

In 1976 the Congress passed the National Science and Technology Policy, Organization, and Priorities Act. The Congress (1) set a national policy of a sound and healthy technological structure, (2) established the position of Director of OSTP, who also serves as Science Advisor to the President, (3) outlined organizational elements for Federal planning in science and technology, and (4) declared that scientists, engineers, and technicians are an invaluable national resource to be as fully utilized as possible.

OSTP was established as a focal point concerned with broad-ranged science and technology problems and bringing these issues into public policy decisions at the Presidential level. Specifically, the act directed OSTP (as one of many tasks) to encourage the development and maintenance of an adequate scientific and technical manpower data base and to use it to assess the Federal impact on these human resources.

Formulas had been suggested as a means of avoiding a decline in Federal science and technology support while national needs are increasing. However, during congressional consideration of the OSTP legislation, proposals for a rigid formula linking funding to the gross national product were not adopted.

Currently, OSTP and NSF monitor the scientific and technological enterprise, including science and engineering manpower, for Government-wide trends, implications, and problems. OSTP maintains an ongoing, but not extensive, activity of its own and stays aware of the activities of other agencies, particularly NSF. The President's 1977 reorganization plan altered some of OSTP's functions. Requirements for the annual and 5-year outlook reports on science and technology problems and opportunities were assigned to NSF.

The Comptroller General testified in 1974 and 1975 about the importance of developing an early warning system and preparing an annual report on the status of the Nation's science and technology. 1/

We believe that the legislation's success depends on how well Federal actions conform to the long-term goals and how effectively OSTP and NSF monitor changes in programs and funding.

NSF officials said that it is important to distinguish between coordinating the impacts of Government actions on manpower and assessing and monitoring the impacts and trends. They noted that advances have been made in gathering statistics and forecasting, but there is no primary agency focus for coordination.

Importance of manpower statistics and forecasts

Successful monitoring depends upon having current, complete, and accurate data and thorough, reliable analysis to understand relationships with the past, the importance of current events, and implications for the future.

As part of its mission to insure the health of American science, NSF has long been concerned with human resources. The National Science Foundation Act of 1950 established NSF with seven major functions, two of which are

--to provide a central clearinghouse for collection, interpretation, and analysis of data on the availability of and projected need for scientific and

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1/Testimony by Elmer Staats, Comptroller General of the United States, before the House Committee on Science and Astronautics on July 9, 1974, and before the House Committee on Science and Technology on June 17, 1975.

technical resources and to provide a source of information for policy formulation by other agencies and,

--to initiate and maintain a program for the determination of the total amount of money for scientific research.

To meet its legislative responsibilities, NSF collects and analyzes statistics on technical personnel. The data and analyses are published in three summary reports entitled, "Composite Report of the Manpower Characteristics System," "National Patterns of R&D Resources," and "Science Indicators." In addition, NSF projects the supply and utilization of doctoral scientists and engineers. Three summary reports have been published and another is forthcoming. NSF also publishes the supporting details of its analyses and projections.

NSF has made efforts to improve its technical ability to track the health of science. NSF held a seminar in 1974 on scientific and technical manpower forecasting techniques. Subsequently, NSF has sponsored research to learn more about science and engineering human resources issues, including the effective response of supply to changes in demand, the mobility and flexibility of highly educated labor resources, and the severity of the resource's underemployment. One result was that NSF plans to incorporate market variables in its next forecast of Ph. Ds.

Several other potential improvements are underway. A Federal multiagency program entitled, "A Framework for Planning U.S. Federal Statistics, 1978-1989," is to include science and technology statistics. Also, NSF conducted a survey in early 1977 to determine how well reports from its Division of Science Resources Studies met the perceived needs of actual and potential users. The survey should provide guidance in shaping NSF's data collection programs during the next several years.

Recognizing past technical improvements, NSF's chief manpower analyst said that there is still a long way to go. He cautioned that the market system is very complex because of many interacting factors. Because current models are relatively crude, simple analogs of very complex systems, he emphasized that manpower forecasts should explicity state assumptions, evaluate different scenarios, and present sensitivity analyses. 1/ He believes that the main purpose of modeling is not necessarily the production of predictions or forecasts, but rather the development of a better understanding of the manpower system being dealt with and the factors that drive it.

FORECASTS--USEFUL BUT INEXACT

The delegating of oversight responsibilities to OSTP and continuing efforts by NSF to learn more about the working of the labor market are positive steps toward improving Federal forecasting. Forecasting can be a useful tool in formulating Federal policy and actions. However, the limits in forecasting the future supply and conditions for utilizing scientists and engineers must be recognized.

Forecasts can provide policymakers an early warning of potential future imbalances and can describe the likely result if a certain set of circumstances happen, but they cannot predict precisely what will happen.

Some market analysts have concluded that the labor market for scientists and engineers generally conforms to the neoclassical theory of a free market. 2/ However, it is affected by some lags in response to changing conditions and some rigidities, such as tenure in academic institutions. At present, labor analysts can describe the interrelationships in the market and the likely results, but not with precision. For example, forecasters know that human resources can be substituted for one another. But they do not know precisely to what degree this exists for scientists and engineers.

Forecasters are striving to improve their understanding of the science and engineering labor market, but some circumstances that can dramatically affect the supply/demand

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1/Sensitivity analyses describe the results of an analysis change when values of key behavioral parameters are varied.

2/The theory holds that prices reflect changes in supply and demand conditions and resources respond to price changes. Economic theory also assumes that those in the market have current, complete, and accurate information upon which to base their decisions.

relationship are not predictable and, therefore, cannot be incorporated into manpower forecasting models. Many forecasts have not predicted changes in national priorities, certain demographic changes, technological advances, and shifts in the economic growth rate.

Forecasts can only tell the outcome of a given future and not what that future will be. An unpredictable event, such as Sputnik, could trigger another period of rapid growth. The Government, reflecting changing national needs, could rapidly shift priorities and funding, as happened in the space program cutbacks.

Even though policymakers may be alerted to potential imbalances, they may still happen. For example, the Congress mandated that the Government should support science and technology commensurate with national needs and opportunities and the prevalent economic situation. However, Federal support is not unlimited. Therefore, national priorities may emphasize needs other than those programs which could intensively use the skills of scientists and engineers and an oversupply may occur.

There are additional reasons for uncertainty and impreciseness in forecasts. It is hard to predict how long it will take institutions and individuals to respond to changing conditions. An instance of lagging institutional response occurred during the passage of the OSTP legislation. An early version of the bill, introduced in 1971, contained a provision to create 40,000 jobs for scientists and engineers to meet a predicted job shortage. After 5 years, the bill passed without the provision.

An example of response lags by individuals occurred when space program outlays declined by $2 billion between 1966 and 1969. The number of science and engineering students enrolling for graduate work continued to increase until 1971, apparently in part because of a propensity to expect past trends to continue. NSF officials considered this to be a relatively quick labor market response. Ideally, such responses would be quick and of mild proportions.

Furthermore, the Government does not control the factors in a free labor market. Federal programs can influence an individual's decision but, in the decentralized American labor market and political system, the individual is free to make his own final decision. For example, the Federal reemployment assistance programs for scientists and engineers, although reasonably successful, found many roadblocks to getting the unemployed back to work. They resisted accepting lower paying jobs and moving to other geographic locations.

IS MORE INFORMATION THE ANSWER?

Knowledge of the science and engineering labor market could always be increased, but the increase may not always be worth the cost.

When Federal research and development obligations dropped about $1.6 billion (in constant dollars) between 1969 and 1972, the cutback was a cause for increased discussion of the need for improved forecasting. However, a former Presidential advisor and manpower specialist wrote,

> "* * * A great amount of foresight was not necessary to recognize that any drop in the rate of increase of Federal expenditures for research, and certainly a leveling-off or a reduction, in the face of rapid increases in the manpower supply, would result in turmoil, and that is exactly what has happened." 1/

NSF officials agreed with this observation, but said that overall trends are not enough and further analysis is necessary to forecast the effect on different fields.

In "Human Resources and Labor Markets," three manpower specialists, 2/ stated,

> "* * * It was not for lack of knowledge that inadequate provisions were made for teachers and classrooms to serve the post-war baby boom or that insufficient jobs were generated to absorb veterans returning from Vietnam or engineers laid off in the aerospace industry."

They concluded that

> "* * * the manpower problems of the past few years cannot be blamed on the lack of information concerning the manpower future."

1/Eli Ginzberg, The Manpower Connection--Education and Work, 1975.

2/Sar Levitan, Garth Mangum, and Ray Marshall (currently the Sec. of Labor), Human Resources and Labor Markets, 1976.

The three went on to advise users of manpower data to generally

> "* * * accept the fact that even with the best of techniques the future will remain opaque; use projections with patience and wisdom and have faith in the far-from-perfect but reasonable flexibility of the labor market and the adaptability of human beings."

Several other manpower analysts studied 376 manpower models and concluded that manpower forecasting has only limited policy value, but information was not a principal constraint. 1/ They wrote,

> "* * * In particular, manpower planning in the United States is limited by the concept of planning as a decision instrument, and by institutional gaps in the policy and operating systems that planning intends to serve."

They concluded that planning requires a systematic flow of information and decision criteria and an organization responsible for exploring alternative ends and means in a long-term perspective. 2/ Therefore, any request for more information will need to be evaluated.

NSF's 1977 survey of its data users showed that almost one-half of those making suggestions wanted greater disaggregation of data. NSF concluded however, that,

> "Very few of those respondents indicated any awareness of or concern with the practical difficulties or expense involved in collecting and making available information at the level of detail or disaggregation they suggested."

We believe that better and more information is a legitimate constant concern of those striving for improved policy

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1/S.C. Kelley, T.N. Chirikos, and M.G. Finn, Manpower Forecasting in the United States: An Evaluation of the State of the Art, 1975.

2/S.C. Kelley and T.N. Chirikos, "The Policy Value of Manpower Planning in the United States," article in Modeling and Simulation for Engineering Manpower Studies-Proceedings of a Conference, National Academy of Sciences, 1977.

analysis, but a careful cost/benefit assessment should be made of requests for more information to be used for better matching the supply and demand of scientists and engineers.

CONCLUSIONS

Forecasting the science and engineering labor market and the impacts of Federal actions on this market is a useful tool in formulating policy, but must be recognized as an inexact science.

Forecasts can be used to assess the impact of Federal actions, compare alternative actions, and identify potential bottlenecks and tradeoffs in competing goals. Continuing research has identified many factors at work in the labor market for scientists and engineers, but quantitative measurement of these interrelationships is still not precise. As a minimum, the Government must assure the necessary technical base to identify situations that may warrant Federal intervention.

Policymakers should have the best forecasts possible, but continued efforts to improve the Government's forecasting ability should be encouraged only after evaluating whether the added information is worth the cost.

We were informed that NSF recently established a panel of experts to advise the Foundation on its information responsibilities. A panel subcommittee is to suggest ways that NSF can improve its collection and analysis of scientific and technical personnel data. We believe that the panel could enhance its value to NSF if there was more participation from the science information user community.

Inherent uncertainties and limits to the use of forecasts must be recognized. Forecasting improvements and the new science policy structure have reduced the likelihood of a potential supply/utilization imbalance happening without the Government knowing about it. However, even further forecasting refinements will not preclude imbalances from happening because:

--Unpredictable events may happen.

--National policy may change dramatically due to emerging, changing, or competing national needs.

--The Government influences, but does not control the supply of scientists and engineers.

--The expected response to change of those in a free labor market has been imprecisely modeled.

--Lags appear inevitable in recognizing a problem, decisionmaking, and implementing the decision to affect the free labor maket.

The Government has great influence on the science and engineering labor market, but its predictions of the future and the marketplace performance are imprecise. Therefore, an executive branch focal point is needed to establish clearly defined long-term goals, analyze the potential benefits and risks of alternative policies, decide whether or not Federal action is warranted, and evaluate scenarios of possible outcomes of alternative plans.

RECOMMENDATIONS

We recommend that the Director of OSTP and the Director of NSF improve evaluation of the implications of major Federal actions for scientists and engineers:

--Include an overall assessment of the Federal impact on scientists and engineers as part of the annual report and the 5-year outlook report on science and technology required by law, thus providing appropriate visibility and distribution. This assessment should, as much as possible, broadly describe the likely impacts from probable major new Federal initiatives or funding cutbacks; quantitatively report the current market for scientists and engineers and qualitatively portray several probable future scenarios; and highlight special, unusual, or important problems or imbalances between the supply of scientists and engineers and the Nation's requirements.

--Include more users on NSF's newly formed panel on manpower information to get formal comments and suggestions and, thus, better advise on the user community's science and engineering manpower informational needs.

CHAPTER 3

A CASE STUDY: IS THERE A PROSPECTIVE

LOSS OF YOUNG SCIENTISTS IN ACADEMIC RESEARCH?

In this chapter we examine the Government's involvement in a current scientific manpower issue--the perceived shortage of job opportunities for young scientists 1/ aspiring to go into research in the Nation's universities. We considered the Government's use of its data and statistics to assess the magnitude and seriousness of the reported problem, and its consideration of the need for intervening actions by the President or the Congress in response to the perceived threats to the Nation's science and technology.

Projections for the 1980s show that the number of 18- to 21-year-olds, who traditionally go to college, is likely to decline. College enrollment projections show a corresponding decrease by the mid-1980s. These trends point to a decrease in the need for new junior faculty. Reports show that there will be a limited number of faculty vacancies in the 1980s; many faculty members will be relatively young and tenured. The scientific community, therefore, became concerned about a severe lack of faculty positions in universities for young scientists during the next decade.

The Director of OSTP and other national science leaders were concerned that the declining number of available university faculty positions for young scientists could hurt the future strength and creativity of American science. In NSF's 1976 annual report, the Acting Director pointed out that the situation threatened a virtual lockout in many disciplines and, over the longer term, could impair scientific performance.

In November 1977, the President noted that the percentage of young science faculty members had fallen from about 45 percent in 1968 to around 25 percent. He said that this "shows that in the future we have a problem on our hands unless we take strong action to correct these trends."

1/A young scientist is defined as a scientist or engineer who has received a Ph. D. degree within the last 7 years. NSF uses the term young investigator.

In February 1978, the Director of OSTP told a Senate Subcommittee that the Nation's scientific and technological enterprise appeared to be reasonably healthy, but one particularly troublesome concern was the diminishing opportunity for young scientists in academic departments.

Subsequent increases in fiscal years 1979-80 Federal budgets for basic research were recommended, in part, to help alleviate the shortage of job opportunities for young scientists.

Because of the inherent forecasting difficulties and uncertainties and the recognition that higher education and Federal funding were growing at an unusually rapid rate in the 1960s, we are concerned about trend data which used that period as a base point. In our opinion, the Government needs a standard to which the trend could be compared.

In a recent evaluation of options for postsecondary education policy, the Congressional Budget Office first identified Federal goals and, second, determined each goal's achievement and the extent each remained a problem. These steps seem like an ideal way to proceed in evaluating the young scientist issue.

OSTP and NSF should provide their judgment and quantify, as much as possible

--the minimum flow of young scientists into academic research necessary to insure the strength and creativity of science;

--the gap which could occur between this flow and the likely flow without further Federal action; and

--the costs, potential benefits, and long-term risks of additional Federal actions.

During the course of our review OSTP and NSF initiated some steps along these lines.

IMPORTANCE OF YOUNG SCIENCE FACULTY TO THE STRENGTH OF SCIENCE

The percentage of young science faculty at the universities where most of the Nation's basic research is performed has reportedly been declining. Of the Nation's 3,000 or so colleges or universities, approximately 290 universities grant Ph. Ds. These schools do 53 percent of the Nation's basic research, which is 98 percent of all the basic research performed at colleges and universities. Thus, the doctorate-granting institutions are particularly important to the Nation's science effort.

Science community leaders have cited surveys and anecdotal evidence to show the decline in young faculty. Taken over an 8-year period, three surveys 1/ of graduate department chairmen in selected fields at doctorate-granting institutions showed the percentage of young science faculty fell from 39 percent in 1968 to 28 percent in 1974 and 1975, and is projected to drop slightly to 25 percent in 1980.

This trend was substantiated by the department chairmen providing data for all three surveys. For these 450 departments in 12 fields, the percentage went from 43 percent in 1968 to 29 percent in 1974, to 27 percent in 1975, to an estimated 23 percent in 1980.

The science community is concerned about this decline because it believes that the infusion of new ideas from young faculty is essential to the soundness of basic science. However, according to one former member of the National Science Board, this change in age distribution is not easy to assess.

The former Board member believes that scientific productivity probably peaks at an early age, but he also believes that the evidence is not conclusive because the exponential growth of science has meant that, up to now, the proportion of young scientists has always been high.

1/The three surveys are:

"Support and Research Participation of Young and Senior Academic Staff, 1968," NSF 68-31.

"Young and Senior Science and Engineering Faculty, 1974: Support, Research Participation, and Tenure," NSF 75-302.

"Young Doctorate Faculty in Selected Science and Engineering Departments, 1975 to 1980," Higher Education Panel Reports, Number 30, American Council on Education, August 1976. (Survey made in 1975.)

He cited one noted study of age versus scientific productivity that was unable to reach definitive conclusions on the matter. 1/ He had no doubt, however, that on the average, scientists spend a much higher proportion of their time in research when they are young.

NECESSARY LEVEL OF YOUNG SCIENCE FACULTY YET TO BE DETERMINED

If it is accepted that some young science faculty is important to the health of the Nation's academic science, we believe that the necessary level should be determined. In our opinion, unless the current downward trend is compared to a standard, it denotes a change, but not necessarily a problem.

Some forecasters and policymakers have cited the decline but have not stated what the percentage or number of young scientists should be. NSF officials told us that making such a quantitative estimate is difficult.

One way to make this estimate is through opinion surveys. In the 1975 survey conducted by the American Council on Education, graduate department chairmen responded that, on the average, 30 percent was the most desirable percentage of young scientists to have on a faculty. The survey did not report what specific criterion the chairmen used to decide the number of young scientists desired, other than their considered professional opinion.

An NSF staff study 2/ prepared for the National Science Board in May 1978 evaluated alternative programs for young scientists. The report noted that the increasingly higher proportion of older faculty in most disciplines is partly the result of the unusually young faculty composition existing in the 1960s because of rapid enrollment growth. Therefore, the study found no established standard for setting the proportion of faculty that should be young scientists. However, the report observed that there may be a consensus among NSF officials that the proportion of young scientists should not drop below 20 to 25 percent.

1/Harvey Brooks, The Dynamics of Funding, Enrollments, Curriculum and Employment.

2/Memorandum, dated 5-16-78, to members to the NSB Programs Committee from the Office of the Asst. Director for Scientific, Technological and International Affairs (NSB-PC-78-9).

We used the results of the 1975 survey of graduate department chairmen to try to illustrate the magnitude of the potential shortage. The survey obtained estimates from the chairmen of 236 (out of 377) distinguished or strong 1/ science and engineering graduate departments in 14 disciplines. We compared their estimates of the number of young faculty that ideally would be on their faculty in 1980 with those expected actually to be in the faculty composition at that time. As the following table shows, the estimate of 1980 onboard young faculty will be 450 short of the desired number.

Departments	Departments in the survey	Projected shortfall of young faculty, 1980
Biochemistry	18	21
Botany	12	12
Chemical engineering	13	15
Chemistry	32	71
Economics	11	(1)
Electrical engineering	21	70
Geology	16	26
Mathematics	17	75
Microbiology	14	(1)
Physics	20	80
Physiology	12	19
Psychology	24	41
Sociology	18	13
Zoology	8	15
Total	236	a/450

a/Figures do not add due to rounding of the detail.

If this number were to be added to the faculties, the young science members would increase from 1,451 to 1,901, or about 31 percent. However, the number of positions for young science faculty based on the survey data could be much greater than 450. For example, when we extrapolated the results from the 236 departments to all 377 distinguished or strong departments, the number of additional young faculty

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1/Classification based on the 1970 Roose-Anderson survey of graduate departments.

that would be needed increased from 450 to 719. Thus, to meet the chairmen's desired level, each department would need, on the average, about two more young faculty than anticipated.

NSF extended our illustration by projecting that if distinguished and strong departments in all science and engineering fields were included, assuming those not covered by the survey have similar needs, the additional number desired climbs to about 1,154. Furthermore, including the departments classified as good or adequate, the needed number of openings for additional young faculty becomes about 1,850.

Potential impact of Federal actions

The department chairmen's survey instructions directed that 1980 estimates be made on the assumption of no substantial increase in Federal research funding. However, increases in Federal basic research funding could greatly add to the numbers of young science faculty.

In an April 7, 1978, speech, the President's Science Advisor stated that he was recommending an 11-percent increase in 1979 Federal basic research funding. He estimated that such an increase would allow an increase of some 700, and perhaps 1,000, new full-time doctoral positions. This projection was based on an NSF analysis. To illustrate the impact, the science advisor stated, "that figure [1,000] would result in the equivalent of one new opening in the 50 top departments in 20 fields."

NSF officials emphasized to us that any proposal to effect an increase in positions would depend on full appropriation of the request, continuing the higher level of funding in future years, and maintaining inflation at or below the projected rate. Thus, it would be some time before such a proposal's results, if any, could be measured.

Even without any significant change in Federal funding, the graduate department chairmen surveyed expected that the total number of young science faculty will be about the same in 1980 as it was in 1975. The proportion of faculty that are young may decline, but the number should stay about the same because the overall number of faculty is expected to grow slightly.

PORTRAYAL OF THE OUTLOOK AT RESEARCH INSTITUTIONS

Projections for all colleges and universities show that few faculty positions beyond 1980 will be available for young science faculty. Nonetheless, we do not believe that the outlook for young faculty at all colleges and universities is necessarily representative of the doctorate-granting institutions.

Projections, such as those by Allan Cartter, analyzed the outlook for young faculty at all colleges and universities. 1/ Cartter, for example, did not examine the outlook for specific science disciplines or for those universities which perform nearly all of the academic basic research. His projections, which he called a "speculative first step," have been supplemented by anecdotal information gathered by NSF and others. 2/

However, not all of the critical factors used in forecasting the shortage of opportunities for faculty have been fully explored to determine their applicability to research institutions. For example, the American Council on Education's 1975 survey of doctorate-granting institutions showed considerable variation in the young faculty percentage among the various disciplines, ranging from a 17-percent low in physics to a 40-percent high in sociology.

Three other factors, the future college enrollment trends, faculty death and retirement rates, and the job mobility rates, 3/ when measured in the diversified and stratified American college and university scene, are unlikely to affect each university equally.

1/Ph.D.'s [sic] and the Academic Labor Market, Allan Cartter, 1975.

2/Examples include: The State of Academic Science by Smith and Karlesky, Science at the Bicentennial by the National Science Board, and Research Universities and the National Interest by the Carnegie Corporation of New York and others.

3/There are other factors such as the level of future financing of higher education and the ratio of students to faculty.

We do not believe that enrollments at the leading research universities will decline at the same rate as at all colleges and universities, due to changing demographics. A study for the National Science Board noted, in part, that

> "* * * it is anticipated that fluctuations in enrollments will also vary significantly between universities. It is likely that the more prestigious universities will have greater control over the size of their enrollments and, consequently, faculty."

In addition, a recently completed study for NSF 1/ found that the pressure of cutbacks in enrollments and return to "the steady state" has not affected all research universities equally. The stronger departments seem to be in better condition. In some cases, top university departments have already experienced cutbacks in graduate enrollments while continuing research funding at an adequate level.

We found a scarcity of summary information about the aggregate number of faculty at leading universities likely to retire or change jobs in the 1980s. This led us to agree with a conclusion from a recent NSF study:

> "At a minimum we need to know how many of our leading science departments are heavily tenured and face a 10- to 15-year period with few retirements. If the number of such departments is large, then an important and creative role will clearly exist for Federal agencies, such as the National Science Foundation and the National Institutes of Health, and for private foundations concerned with the health of academic science, to help university administrators find new ways to employ young faculty." 2/

Government and other observers, stressing the value of America's decentralized and diverse academic setting, have placed the principal responsibility for addressing the tenure and aging faculty question on the universities.

1/The State of Academic Science, Smith and Karlesky.

2/David Breneman, article in The State of Academic Science-Background Papers.

In November 1977, the National Science Board reported to a House Subcommittee that there are no simple solutions to the problems confronting the Nation's young scientists:

> "Given the inherent uncertainties of forecasting the long-term supply and demand for research scientists, it appears that the strategy with the greatest promise is that of systematically increasing the possibilities for exchange of personnel among the academic, private, and government sectors."

We believe that increasing the mobility of researchers among the three sectors needs to be closely evaluated in light of the critical importance given it by the National Science Board.

Young nonfaculty researchers need considering in projections

The data projecting a decline in the strength of science is based on a decreasing number of university faculty positions available to young scientists. However, these projections do not consider nonfaculty postdoctoral researchers. Should they be included, the number of young researchers in some fields may actually increase.

NSF officials believe that most postdoctoral researchers should be excluded in the count, as young researchers do not have the freedom to pursue their ideas independently. Postdoctorates generally get support as members of a senior faculty member's research group and are committed to the conceptual thrust established by the principal investigator. The National Academy of Sciences is studying the increasingly important role of nonfaculty postdoctoral researchers in American science.

FACTORS THAT NEED CONSIDERING

NSF officials pointed out that, in assessing the need for and scope of Federal intervention, qualitative and quantitative factors need considering. One official said that, in achieving the goal of long-term health of science, Federal actions could include insuring an adequate flow of talented people into science or providing optimum opportunity for the best young people already in science to use their talent.

We believe that incorporating these qualitative factors into assessing the need for Federal action is appropriately the responsibility of OSTP and NSF. Inserting a qualitative factor could mean making optimum use of a desired fraction of each generation's creative individuals, so that they have the opportunity to pursue innovative ideas.

Such assessing depends on determining the desirable fraction and creative individuals present in each generation. For example, if the number of creative individuals were defined as the number of recently graduated Ph. Ds., then the result would depend on how many people wanted to become Ph. Ds. A policy which defines a goal in terms of meeting a fraction of some base is dependent on the size and changes in that base.

Several manpower forecasts predict that in the early 1980s less than one in five Ph. Ds. will likely find academic positions. We believe that the various data need assessing to see which will insure the vitality of science: a goal of the number, quality, and optimum use of young scientists; or a certain proportion of faculty in the young category; or a certain percentage of Ph. Ds. with college teaching jobs; or a combination of these.

NATIONAL SCIENCE FOUNDATION'S CURRENT ACTIONS

In discussing our report, NSF officials said that their concern about the soundness of science recognizes the importance of young research scientists. They also recognize the uncertainties in assessing the potential harm of the reported decline in the numbers of these young scientists.

NSF noted that universities and colleges are likely to go through some major changes over the next few years. As a result, opportunities for young investigators will be affected and may need expanding. NSF officials said that a clearer picture is developing as they continue their assessment. For example, they now believe that the lack of job opportunities primarily may be in certain disciplines and it may be possible to fix the period during which the lack will continue.

NSF has become aware of certain perspectives--appreciating the uncertainty of peering into the future, examining the issue by individual academic disciplines, and looking at other more sophisticated models. These include models for faculty age composition, the idealistic and realistic conditions for universities to assume in a steady state situation, and the way universities will make the transition. NSF, therefore, deems it unwise to propose across-the-board solutions without this sharper focus.

NSF has continued to update its data. A February 1979 report gave the results of a survey of the roles of young doctoral faculty in the academic community. A forthcoming report will project the supply and utilization of doctoral scientists and engineers. These updated reports give new information on the continued downward trend in the proportion of young investigators, quantified by fields of science, college enrollment patterns, and job prospects for young scientists.

Some NSF advisory committees have begun evaluating young faculty needs in their individual academic disciplines. If a committee should need immediately to alleviate the problem in a particular discipline, NSF would fund new proposals from existing NSF budget allocations.

NSF has begun to study the costs and benefits of some possible Government programs and plans to further evaluate models. The National Science Board is to discuss this issue in the near future. NSF officials said that they plan to provide the Director of OSTP with recommendations for the fiscal year 1981 budget-cycle if they believe that actions outside of NSF are warranted.

CONCLUSIONS

Manpower forecasts have alerted policymakers to a possible decline in opportunities for young scientists to do research at universities and have identified some of the causes. Young doctoral faculty are believed to be productive and innovative elements to the soundness of science. Surveys have shown that the percentage of young science and engineering Ph. Ds. at doctorate-granting institutions fell from 39 percent in 1968 to 28 percent in 1975 and is projected to drop to 25 percent in 1980.

Federal officials have used these forecasts to show the seriousness of the issue and to try persuading universities and others on the need for action. An increase in Federal funding of basic research for the past 2 years has been proposed, in part, to improve the perceived lack of job opportunities for young scientists.

We were concerned about the use of data and projections in assessing the lack of job opportunities for young research scientists. There are inherent difficulties in forecasting future trends in the labor market for scientists and engineers. (See ch. 2.) Also, some of the public statements describing the downward trend in the proportion of young faculty did not state what the percentage or number of young scientists should be.

NSF is planning to further define and refine the information necessary to show the need, if any, for further Federal initiatives. These steps are appropriate for effective analysis of an issue likely to remain a concern for some time. As a part of this analysis, we believe that certain factors need to be fully explored.

A standard for the percentage or number of young scientists in the 1980s has not been stated. Although quantitative estimates are difficult, an opinion survey of department chairmen was taken which showed that, on the average, 30 percent was believed to be the most desirable percentage of young doctorates among the total faculty. An NSF study conceded that the proportion should not drop below 20 to 25 percent. According to a recent NSF report, no universally accepted standard exists for the most effective proportion of recent doctorates on full-time science and engineering faculties.

Federal officials should state as definitely as possible the number, proportion, and quality of young investigators needed for the health of science. NSF officials said that this is desirable, but not easy to quantify. We recognize the difficulties, but, in our opinion, Federal officials should render their considered professional judgment, quantified to the extent practicable.

The future trends of factors affecting the number of openings for young scientists on faculties remain uncertain. Three such factors are future college enrollments, faculty death and retirement rates, and faculty job mobility rates.

Some question remains as to whether the projected outlook for young faculty openings at all colleges and universities represents those colleges and universities where most basic research is done. Also, there are variances among various academic disciplines within the reported overall downward trend.

The degree to which universities can, should, or will mitigate this trend is uncertain. The results of past Federal actions, such as increases in basic research funding, are unknown. Future Federal actions should be based on the results of these and other efforts.

In summary, we believe that Federal officials recognize the issue's complexity, the uncertainty of forecasting future trends, the importance of defining and scoping the problem as clearly and accurately as possible, and the need for continuing analysis of many important factors bearing on Federal action.

RECOMMENDATIONS

In bringing the scarcity of opportunities for young research scientists into sharper focus, the Director of OSTP and the Director of NSF should

--assess the seriousness of the issue and characterize, as definitely as possible, the flow of young scientists desired and needed to insure the future strength and creativity of American science;

--describe the current situation and future flow likely to occur without Federal action; and

--evaluate and propose Federal initiatives, as needed.

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