094310

U.S. GENERAL ACCOUNTING OFFICE
WASHINGTON, D. C. 20548

Staats


PUBLIC LECTURE BY
ELMER B. STAATS
COMPTROLLER GENERAL OF THE UNITED STATES

ROUND TABLE ON SCIENCE AND PUBLIC AFFAIRS
DUKE UNIVERSITY GRADUATE SCHOOL, DURHAM, NORTH CAROLINA

NOVEMBER 28, 1979

# CURRENT NATIONAL ISSUES INVOLVING SCIENCE AND TECHNOLOGY

Nearly 18 years ago, in an address to the annual meeting of the Corporate Associates of the American Institute of Physics on "New Knowledge in Physics and the Economy," Peter Drucker stated that:

> "Scientific research is no longer tangential to the economy; it is at its dynamic core. Conversely, social developments are no longer tangential to scientific research; they are a major determinant."

Today we face the realities that amplify the full meaning of Drucker's proposition.

Since World War II, science and technology have been recognized as vitally important to national defense and as key ingredients to economic growth. Economists agree that there is a high positive correlation between science and technology and the economy. However, we do not yet fully understand the linkages connecting research, development, innovation, and productivity, nor are we able to precisely measure those linkages.

~~094310~~
710355

The 1970s have been characterized by increasing social concern about the risks associated with science and technology: nuclear accidents, cancer-causing food additives, adverse side effects of new drugs, and the potential harm of genetic engineering. As public pressures have mounted, governments at all levels have established social regulations for environmental protection, equal employment opportunities, employee safety, product safety, and consumer protection. Some of these regulations have stimulated innovative technology; others have increased the costs of doing business and diverted capital that otherwise might have been invested in research and development. Social concern has also revealed major conflicts between values and policy objectives, such as the desire for technological innovation and economic growth versus the desire to protect the quality of the environment.

As our national priorities have shifted, the emphasis on reducing risks to human health and improving the quality of life is often cited as contributing to slower economic growth and reduced productivity. In addition, the climate for scientific research and technological innovation has been greatly affected by inflation, economic uncertainty, and the complexities of government regulations.

The situation is compounded further by the increasing economic interdependence of all nations for food, energy,

minerals, space utilization, ocean resources, and atmospheric pollution. Sharing U.S. technology with other nations involves some hard choices. How can we, for example, promote international trade without weakening national security? How can we assist developing countries without compromising U.S. industry and domestic jobs? Science and technology offer great potential for improving the quality of life throughout the world, but gaining international cooperation to achieve this goal is inhibited by a lack of understanding and trust that is deeply rooted in cultural, ideological, and value differences.

Because science and technology increasingly interact with society, our Federal Government, as the surrogate for the public, has become the dominant partner in guiding and influencing the direction of U.S. science and technology. This influence is achieved not only by the direct funding of over half the Nation's R&D, but also by the setting of tax, fiscal, and regulatory policies which directly or indirectly affect R&D in the other two major sectors engaged in science and technology work--universities and industry.

Public pressure to limit Federal expenditures and increasing emphasis on congressional oversight are forcing tight competition and accountability for federally supported research. These pressures create tensions between the academic community and the Government, and they stimulate concern about whether

the vitality of U.S. science is being threatened. There also is much concern about the perceived decline in industrial innovation and how this affects productivity, the economy, and the U.S. position in international affairs.

In this context--the increasing interaction of science and technology with society and the concomitant increase of Federal involvement--I would like to focus your attention on several national issues in science, technology, and public policy which transcend individual Federal agencies and programs. These issues are (1) increasing tension in the Government-university partnership in basic research; (2) a perceived decline in the rate of U.S. industrial innovation; (3) the need for closer cooperaton in research between industry and research universities; and (4) the need for improved measures and criteria to support Federal decision-making in science and technology policy.

The public as well as the science and technology policy community are concerned about these issues because they relate to the Federal role in providing leadership, support, and a favorable policy environment for both academic and industrial research and technology innovation. These unresolved problems on the domestic scene present challenges and obligations to each sector of the research and engineering community.

Issue No. 1: Tension in the Government-University Partnership

In 1963, Business Week ran an article entitled "Uncle Sam: Big Man On Campus." A cartoon accompanying the article read: "University scientists welcome federal research grants--but not federal sleuths out to see how money is spent." The cartoon pictures a distraught scientist surrounded by auditors spilling chemicals, sifting through wastebaskets, and squinting through microscopes.

In 1979 the belief still persists that Government auditors wreak havoc in the scientific workplace. The President of the University of Rochester, Robert Sproull, has written that "auditors produce only inefficiency and put blinders on research when they attempt to restrict every dollar to the precise purpose they think Congress has in mind."

He and other spokesmen for the Nation's leading research universities argue that the Government's demands for financial accountability threaten freedom of inquiry and diminish risk-taking in basic research. They characterize the relationship between Government and universities in terms of erosion, decay, and deterioration.

To judge the merits of this characterization, I would like to call your attention to some of the nuances of the Government-university relationship.

As a result of Federal support of research, today our leading research universities occupy a position of strength and vulnerability due to the Federal support of research. On the one hand, Federal funding has helped a number of institutions to achieve the enviable status of "centers of excellence." On the other hand, Federal support has prompted these same institutions to become extremely sensitive to changes in funding caused by shifting of national priorities and to the different management practices of Federal agencies. While overhead costs rise, administrative burdens increase for universities attempting to comply with Federal regulations and procedures.

The Federal Government, as the major sponsor of university research, is beset by public pressures. These pressures have exerted a profound impact on the Government's relations with research universities. I am referring to the significant increase in public calls for accountability. Note, for example:

--initiatives to limit Government taxing authority and public expenditures;

--public mistrust of all large institutions, a mistrust due to exposures of carelessness and instances of outright fraud;

--tightening of Federal spending and greater competition for scarce funds; and

--increased congressional oversight of Federal programs.

It is my conviction that the first step toward improving the relationship between the Federal Government and universities should be to discuss and to understand the pressures and constraints on each partner. In 1976, a Vice-President of the American Council on Education called for a "moratorium on indignant rhetoric and vague laments that government will be the death of us." Too often the academic community has failed to acknowledge the constraints on Government as a surrogate for the public interest.

For example, pressures for financial accountability apply to all Government programs in all instances where the Government has stewardship for public funds. Universities are no different than other institutions that receive public funds--and public money must be accounted for. The public demand for fiscal accountability of university research is especially appropriate since the public understands little of what the research actually entails. It is reasonable that the public require increased fiscal accountability of university research in order to retain some check over public research expenditures. Similarly, universities should not expect exemption from Federal social regulations which affect other parts of society. In mandating adherence to social regulations, the Federal Government is again acting as a surrogate for the public interest.

Clearly the very real and legitimate demands of Government present a dual challenge to the universities and to the Government itself. The challenge to universities is to recognize that some changes in their accountability systems are essential and to work constructively with Government officials to solve our dilemmas. A nostalgic yearning for the halcyon years of Government-university relations will not meet this challenge.

The recent formation of the National Commission on Research by groups such as the Association of American Universities and the National Academy of Sciences signals a recognition by the academic community of the need to replace rhetoric with careful study of the controversial issues in Government-university relations.

The challenge to Government is to adequately represent the public interest while recognizing the unique character of the basic research environment. The Government must minimize the controls and administrative burdens that inhibit intellectual inquiry and efficient performance of research.

The Federal Government has already taken positive steps. The Carter Administration, for example, recognizes the importance of a stable base for funding university research from year to year. And the National Science Foundation is experimenting with a Master Grant approach to research funding which

allows a university department to pool the resources of several grants.

In Congress, Don Fuqua, Chairman, House Committee on Science and Technology, has introduced a bill for biennial budget authorization, which is a step toward ensuring stability of funding patterns for research and development.

In the General Accounting Office, we believe there is room to experiment with alternative funding mechanisms. GAO's interest in issues related to basic research and R&D efforts is demonstrated by its studies of:

--the adequacy of Health, Education and Welfare audits of the 20 academic institutions that received the most Federal support during fiscal year 1975, and for which HEW was assigned auditing responsibility;

--the increase in health research indirect costs; and

--the effectiveness of the peer review system in grants to universities by the National Science Foundation and the National Institutes of Health.

--the feasibility of common audit guidelines for Federal grantees, standardization of regulatory requirements, and the conduct of audits of grantees by a single agency.

In terms of research support, the Federal Government will likely remain "Big Man On Campus." But we need new and more creative forms of dialogue between universities and the Government to ensure that the U.S. capability for research is maintained.

Issue No. 2: Declining Innovation

How can the Federal Government improve the climate for innovation so that it will promote economic growth and improve the quality of life in the United States?

Innovation is the process of combining resources in new ways which are more satisfying to users than was possible with the old combinations. It includes the development of new products, new processes for producing old products, new sources of supply for raw materials, and new markets for products. I shall use the word "innovation" to refer to the entire process of invention, commercial development, and market diffusion. Innovation contributes both to output as measured in the Gross National Product (GNP) and to the quality of life in less measurable ways, as for example, improvements in medical and pollution control technologies.

Recently, much attention has been given to whether the rate of innovation in the United States has declined. The reasons cited for this perceived decline are primarily:

--the decline in the rate of productivity growth of the U.S. economy;

--the decline in the proportion of U.S. patents taken out by U.S. citizens (as opposed to foreign nationals);

--the decline in the percentage of GNP devoted to research and development since 1964;

--shifts in the emphasis of private industry R&D from long-range, exploratory research to low-risk, short-term projects directed toward incremental product improvements and compliance with Federal regulations; and

--the perception of businessmen and consumers that the U.S. technological position is slipping relative to that of other advanced industrialized countries.

Although some of this evidence may be questionable, we should not deny the importance of U.S. industrial innovation. There is evidence that high-technology industries (as measured by the ratio of R&D spending to sales, or scientists and engineers employed to total employees) tend to have higher growth rates and productivity increases than industries which do not recognize the importance of R&D. Roger Brinner and Miriam Alexander of M.I.T. analyzed a sample of U.S. manufacturing industries. Their findings show that the high-technology industries have three times the growth in output, twice the productivity increase, nine times the employment growth, but only one-sixth the price increases of low-technology firms. When we turn to international comparisons, the high-technology industries also perform well. The U.S. trade balance in R&D-intensive manufacturing industries (chemicals, nonelectrical machinery, electrical machinery, aircraft, and professional and scientific instruments) reached $30.5 billion in 1978, while non-R&D-intensive manufacturing industries showed a

trade deficit of $36 billion. So it seems that high-technology industries do perform more effectively in economic terms.

The perceived decline in innovation has caused concern in Congress, where hearings on innovation have been held during the past 2 years in both Houses. Concern has also been expressed in the executive branch, where a Domestic Policy Review on Industrial Innovation was recently completed and the President announced a range of initiatives including strengthening the patent system, improving the regulatory system, clarifying antitrust policy, and fostering the development of small innovative firms.

At the same time, the past decade has seen a new emphasis on solving old problems of the U.S. economy, such as environmental pollution, occupational safety and health, consumer product safety, industrial competitiveness, and tax equity. Many observers see a conflict between maintaining the traditional innovativeness of the economy and achieving these other widely supported policy goals. Others call for intensified efforts to make better use of research and development done in industry and universities to accelerate the process of innovation.

Although the productivity growth rate in U.S. manufacturing has fallen substantially during the 1970s, the degree to which this is due to decline in research intensity and innovation is not clear. Most informed observers believe that

research and development have been important determinants of the rate of U.S. economic growth, and in particular they can influence productivity change. However, more diagnostic studies are needed to identify the connecting linkages and to assess the degree of correlation between productivity growth, technological innovation, and investment in R&D.

What should the Federal Government do? Many studies have addressed the impact of Federal tax policies and regulations on private R&D investment. In an uncertain economic and regulatory environment, management is reluctant to incur the high risks of the major investments required to move from the R&D-proven phase into the launching of new products or the building of new production facilities. How can the Federal Government alleviate economic and regulatory uncertainties to stabilize the climate for long-term investment? This issue, to a large extent, is concerned with the macroeconomic outlook and the Federal Government's general approach to regulation--especially economic regulation (price controls, monetary controls, taxes, etc.) and social regulation. It also involves facets that vary from one industry to another and some technology-specific factors, especially in environmental, health, and safety regulations.

We need more careful diagnosis of industry-specific problems to provide a better basis for Federal policies--for example,

analyses of the impact of domestic and foreign policies and regulations on capital formation, R&D investment and technological innovation on service industries as distinct from manufacturing, capital-intensive versus labor-intensive, and small, young versus large, mature technology-intensive companies.

However, there are major difficulties in any attempt to tailor Federal policies to specific industry or sector characteristics. These difficulties are very well illustrated in dealing with the role of small business.

Many studies have claimed that small, young R&D-intensive firms contribute proportionately higher rates of innovation than large, mature companies and that, in the aggregate, the contributions of small business to economic growth are of major significance. Proponents of small business enterprise, however, describe special hardships that tend to choke the startup and growth of technology-intensive entrepreneurial ventures. They point to disadvantages from Government tax and procurement policies and from the myriad Federal and local governmental regulations that impose constraints on major industries or business in general. This issue is complicated by various publications which do not carefully define the criteria for small business and do not distinguish between innovative technology-intensive firms and small

business in general. Further studies are needed to identify the major innovative segments of small business, to define the issues more sharply, and to develop more reliable measures of the causal factors in innovation.

Issues No. 3: University-Industry Cooperation in Research

Recently a number of science policy leaders have urged greater collaboration in research between industry and research universities. Lewis Branscomb, chief scientist of IBM, describes "the industry connection" as the wave of the future for higher education in the United States. Branscomb and others call for a more rapid transfer of basic research results from the university to the marketplace. They argue that the development of new linkages between universities and industries might begin to stem the perceived decline in U.S. innovation as well as provide new opportunities for regional and economic development.

But enthusiasm for closer coupling of the academic and industrial sectors for purposes of technical advancement must be tempered by several notes of caution. There are distinct differences in the norms, reward structures, organization, and values of various industries and universities. The university community must carefully consider how links with industry can be forged without unduly constraining the tradition of academic autonomy. The university's mission is traditionally defined by

its commitment to open-ended inquiry. In contrast, industry's concern is with the marketability of research products.

The problem of differing reward structures is particularly troublesome. Industry safeguards information to avoid jeopardizing its position in the marketplace: the university emphasizes publication of research results as a prerequisite of academic advancement. Another aspect of the problem is that the university reward system may inhibit interdisciplinary research, the kind of research of special interest to industry. Despite special institutional arrangements, the rigid disciplinary structure of the university can be an unfavorable setting for interdisciplinary research. Traditionally, faculty promotion and tenure within universities hinges on favorable peer review of research and publication of research results within conventional disciplines. Peer recognition is more difficult to obtain for interdisciplinary research.

Clearly there are benefits to be derived from cooperation for both industrial firms and academic institutions. In an era of fiscal constraint, it is imperative that universities seek new sources of funding and new markets for their processes and products: research and educated individuals. M.I.T. is a good example of a research institution which adapted to financial stress. When M.I.T. lost its private endowment and its funding from the Massachusetts State

Legislature, it decided to develop a "technology plan" to foster closer ties with industry.

Representatives from Government, academia, and industry are keenly interested in developing special resources for technological innovation. Congress is now considering proposals for establishing Centers for Industrial Technology to be located at universities or other nonprofit organizations. The President's Domestic Policy Review on Industrial Innovation recently seconded this proposal.

The efforts of Government to couple academia with industry have been described as "priming the pump" or catalyzing interaction. Some ways in which the Government can act as a catalyst are

--to remove disincentives for cooperation by adjusting Federal rules and regulations in the areas of patent, antitrust, and tax policy; and

--to provide seed money for cooperative research arrangements.

The Departments of Defense, Energy, and Commerce and the National Science Foundation are examples of Federal agencies which are already encouraging cooperation between universities and industry. Since 1973, NSF has funded and evaluated cooperative arrangements in applied research to determine measures of their success or failure. In recent testimony before the Subcommittee on Science, Research and Technology

of the House Committee on Science and Technology, Richard Atkinson, director of NSF, concluded from NSF's experience that the Government's role should be to guide and direct the university and industry research partnership, rather than to control the research agenda.

Interaction between the academic and industrial sectors can also occur without Government intervention. Public policy-makers should carefully study the origins of autonomous arrangements to determine if Government action can help or whether such action is even necessary. The pioneering efforts of Duke University and your sister universities in North Carolina in establishing the Research Triangle Park are well known. Perhaps some valuable lessons have been learned from your experience.

Several professional associations have started programs to foster communication between individuals in universities and industrial firms. The Business-Higher Education Forum of the American Council on Education, the American Chemical Society's university-industry task force, and the American Physical Society's Visiting Physicists Program are examples of such initiatives. Underlying nongovernmental efforts to join the academic and industrial sectors is the important assumption that transfer of knowledge occurs best through personal communication rather than institutional coupling.

Apparently these private initiatives are proceeding well without Government assistance. However, there are situations in which special institutional arrangments for joint research ventures may need Federal assistance in the form of seed money, tax incentives, or removal of disincentives (such as antitrust constraints) that inhibit industrial consortia from collaborating in generic R&D.

The NSF cooperative research program already provides one means of Federal assistance. Established in 1978, it supports R&D projects that are jointly proposed by industry-university research teams. And as a result of the recent Domestic Policy Review, the President has decided to provide $20 million in new funds to NSF in 1981 to support joint ventures and to extend the NSF program to other agencies.

I might add that the General Accounting Office is initiating a study which will:

--evaluate the various modes of university-industry cooperation that have been established with and without Government assistance, and

--identify appropriate Government roles for facilitating university-industry cooperation in research.

Issue No. 4: Measures and Criteria To Support Federal Decision-making

What are the major limitations in the structure and analysis of the "Federal R&D budget" as it is currently presented to Congress? How is this budget generated? How can the measures

and criteria for policy formulation and congressional oversight be improved?

On June 17, 1975, I appeared before the House Committee on Science and Technology in hearings which led to the passage of the National Science and Technology, Policy, and Priorities Act of 1976. During that hearing, I stressed the importance of a better system for examining national priorities in research and development and a better system for assessing such needs for both specific programs and the overall levels of Federal and private support for research and development. In my statement, I indicated that:

> "* * * however great the difficulty of formulating a comprehensive national policy and strategy, I believe that an attempt should be made to provide a national policy for planning and resource allocation for science and technology programs. There are certainly common objectives, such as support of basic research and supplying adequate investment in training, which go beyond the needs of a single agency to meet its progam objectives. This is more true now than ever before. * * * In addition to mission-oriented R&D supported by the various Federal agencies and the private sector, we need to establish a long-term investment policy for Federal support of basic research and graduate education."

The 1976 legislation contains a landmark statement of national policy. It provides guidance to the Nation because it recognizes the tremendous importance of science and technology to the economy and the interrelationship of science and technology to other policies and programs of the Federal

Government. I found particularly important the statement in Section 101(a)(4):

> "Federal funding for science and technology represents an investment in the future which is indispensable to sustained national progress and human betterment, and there should be a continuing national investment in science, engineering, and technology which is commensurate with national needs and opportunities and the prevalent economic situation; * * *."

Elsewhere in the statute--in the Declaration of Policy as well as in Section 101--it is abundantly clear that the Congress was concerned about the condition and vitality of funding for science and technology and the importance of science and technology to changing national goals and priorities. The statute is a clear refutation of the arguments that science and technology programs could and should be looked at only in the context of priorities for individual programs in the budget.

A common misconception is that total Federal investments in R&D are centrally planned in a total analytic framework which relates scientific and technological opportunities to national objectives. In reality, this is not so. What emerges as "the R&D budget" is pieced together from the numerous independent entities in the executive branch. R&D expenditures become a means to achieve larger ends and, as such, compete with other strategies for the departmental dollar.

This diversity of R&D sponsors and performers is a direct outgrowth of our national philosophy of pluralism. In this

new initiatives, and analysis of issues associated with multi-agency programs. In reviewing the strategy for Federal support of R&D, we should pay particular attention to the respective roles of the Government and the private sector and how they interrelate.

Quantitative measurement of the status and trends in science and technology, when properly presented, is a valuable resource for policymaking. Since 1973, the National Science Board has published the Science Indicator series for the purpose of measuring significant changes in the state of science and technology. Such measures are particularly important in view of the need for a long-range Federal strategy for R&D. The long-term perspective is central to both science and technology, particularly for research.

We commend the National Science Board for its effort to design a broad statistical base for understanding and assessing the science and technology enterprise. However, devising science indicators is a very complex and difficult task and the art is still in an early stage of evolution. The development of such indicators is difficult for many reasons, including: the complex nature of science and technology, the diverse and pervasive way both interact with society, and the primitive understanding of the processes and linkages involved. We encourage the National Science Board to continue its efforts and

to experiment with new concepts and types of indicators with an emphasis on evaluating advancements in science and the processes involved in technological innovation.

Conclusion

There is a wide diversity of opinion about whether the Federal Government does too much or too little in its support and influence of U.S. science and technology. There is even greater disparity of views concerning the manner of Federal intervention in realms that used to be considered almost entirely within the purview of the private domain.

It seems evident, however, that the Federal role will continue to increase--both as a patron of science and as the senior partner representing the national interest and society. Public pressure will continue for attention to societal concerns, including human risk avoidance, limitations on Federal expenditures, and increased accountability. In some quarters, pressures are mounting for stronger central Government control, direction, and management of our nationwide science and technology resources.

Federal officials in both Congress and the executive branch are earnestly seeking solutions to the major policy issues involving science and technology but progress is slow because of the complexity of these issues and the pluralism inherent in our domocratic society.

To ensure that our science and technology base remains strong and that our resources are properly utilized, all partners must work together to educate the public and to build mutual understanding, trust, and cooperation so that we can achieve our national goals:

- We must develop enlightened policies and new institutional arrangements to support research and development without compromising the flexibility and integrity of our pluralist system.
- We must develop a national strategy to anticipate future needs and opportunities for science and technology.
- We need greater commitment from each partner to enhance the climate for research, innovation, and fulfillment of national goals. In some cases, commitment may require that parochial desires be subordinated to the national interest.

This concludes my talk. I will be pleased to respond to questions. Thank you.

Speeches 1

context, pluralism means that each agency, rather than one central authority, supports R&D for its own purposes. Each agency considers the ideas and proposals of individual scientists and institutions. The result is that a highly decentralized review system judges the merits of R&D proposals.

Although there is no centrally planned "Federal R&D budget" per se, the Office of Management and Budget annually publishes a "Special Analysis of R&D" as part of the total budget package. This supplement presents an overview and summaries of proposed Federal R&D expenditures.

In my view, a major function of the Federal budget is to serve as a policy document which discloses the Administration's plans and strategy for implementing priority decisions emerging from major policy considerations. The budget should present information on specific mission- or program-related R&D and information on interrelated programs to facilitate the broad oversight of total Federal R&D expenditures in relation to transcendent issues, interagency-related programs, and similar technologies. For the broad oversight, reports (such as the Special Analysis of R&D and the Science and Technology Annual Report) are needed to present the Administration's view of how the total amount and distribution of Federal R&D expenditures relate to transcendent issues and national goals, and to disclose the rationale for major changes in existing programs,

Nov 28-29

COMPTROLLER GENERAL
OF THE UNITED STATES
WASHINGTON, D.C. 20548

November 16, 1979

Dean Frances C. Thomas
Graduate School
Round Table on Science and
Public Affairs
Duke University
Durham, North Carolina 27706

Dear Dean Thomas:

I have your letter of November 1 and am looking forward to visiting the Duke University campus on November 28 and 29.

I find it will be necessary for me to be here for a 3:30 Congressional hearing on the afternoon of November 29 and it will be helpful, therefore, if the morning discussion could be arranged at an earlier time--perhaps 9 o'clock--to enable me to participate and still catch the 11:15 Eastern Airline flight to Washington. Alternatively, I would be happy to have one of the members of our staff join you for the Thursday morning session, in which case there would be no scheduling problem involved.

Sincerely,

(Signed) ELMER B. STAATS

Elmer B. Staats

bc: Mr. Havens
Mr. Fundingsland