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STATEMENT OF

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BEFORE THE

HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY H 350

ON

H.R. 4461, THE NATIONAL SCIENCE POLICY AND ORGANIZATION ACT OF 1975

Mr. Chairman and Members of the Committee:

I am pleased that you are continuing hearings on national science policy and organization. My testimony last year was concerned with historical perspective, philosophy, and personal views developed during a number of years of involvement with this subject in the executive branch and for the past nine years as Comptroller General.

The current hearings are directed at more specific proposals. The Chairman and the ranking minority member of the Committee have introduced H.R. 4461 in the form of an omnibus bill that attempts to capture many proposals advanced in previous hearings as well as from the work of the Committee's excellent staff. I shall address my testimony specifically to the major provisions contained in the four substantive titles of the bill.

TITLE I--NATIONAL SCIENCE POLICY

It is both appropriate and timely for the Congress to enunciate policy for science and technology in relation to national goals and priorities. To my knowledge, the only recent effort to present a comprehensive policy and strategy for science and technology to the Congress was the special Message to the Congress by President Nixon on March 16, 1972. His message called for a strong new effort to marshal science and technology in order to strengthen the economy and improve the quality of life. It also defined a new strategic approach in allocating Federal scientific and technological resources.

In and of itself, it was a commendable effort. In a recent GAO study, however, we attempted to trace developments since the 1972 message, especially changes in Federal research and development (R&D) budget allocations, to determine the extent of implementation of that message. With few exceptions, we were unable to identify substantive changes resulting from it. Both the Office of Management and Budget (OMB) and the Science Advisor, after considering the results of our study, indicated that the 1972 Science and Technology Message should not be regarded as an adequate basis for measuring later actions on R&D budget priorities and overall national strategy for science and technology. It clearly did not represent a systematic effort to provide a national assessment of priorities for science and technology or a plan for its implementation.

Dr. Stever, the Science Advisor, told us that "the 1972 message, and the events that inspired it, related to a number of policy and political conceptions that the passage of but three additional years have shown to be vastly off the mark as measured against the events that have had most influence in shaping new thrusts and initiatives in the Federal support of R&D."

It is now evident that the executive branch does not consider the special message of 1972 to be its official current policy and strategy, and there has been no recent issuance to update such a comprehensive statement. The executive branch views R&D principally as a means to achieve specific program objectives, and believes each mission agency should have the prerogative of developing its own R&D policy and strategy. The executive branch therefore questions the feasibility and desirability of developing a comprehensive policy or statement of priorities for science and technology.

I cannot agree entirely with this viewpoint. It would be difficult to quarrel with the need of each agency to develop a statement of its own R&D policy and budget priorities to support its mission objectives. Still, 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 program objectives. This is more true now than ever before. Among the reasons are our budgetary constraints, declining productivity, and the capital intensity of research facilities--just to name a few. We must also recognize the need for longer term planning of technological needs to better anticipate crises that can be alleviated in part by science and technology, such as shortages in energy, critical materials, and food. The development of a long-term plan would provide a more rational context for the annual incremental budget decisions.

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.

Except for a few large corporations and philanthropic foundations, the private sector generally does not support basic research and education unless it can identify a direct, timely, and adequate return on its investment. Government, and particularly the Federal Government, therefore, must be the major sponsor of basic research and graduate education. Without adequate support of this kind we run the risk of losing the benefits from our international leadership in science and technology. I do not believe there is any

"best" formula for Federal support of basic research--a percentage of the total R&D budget, a percentage of the gross national product, or the consensus of experts in various disciplines; however, I believe that a rationale should be developed and criteria established to assure continuity and stability of federally sponsored efforts.

In reading Title I, I have not attempted to examine the text for completeness, but rather to ascertain whether it is sufficiently definitive to provide meaningful guidance without becoming so structured that it would provide undue constraints on the executive branch's ability to cope with changing circumstances and priorities. On the whole, I believe that Title I satisfies this test.

There are two points on implementation (section 102(b)) and procedure (section 102(c)) which I believe warrant consideration for more explicit emphasis. The first concerns the Federal responsibility for stimulating public technology innovation by:

(1) Fostering improved partnerships and institutional arrangements with State and local governments and the private sector; and

(2) Eliminating barriers to public technology innovation.

I shall expand on this point in discussing Title IV.

My second suggestion is to emphasize the responsibility of the Federal Government to minimize disincentives (regulatory and otherwise) and to provide special incentives to

enhance productivity in both the public and private sectors. This is especially important in situations in which market forces are insufficient to attract the necessary private investment and/or in which externalities inhibit technology innovations that could improve productivity, strengthen the economy, or enhance the quality and efficiency of public services.

Title I, section 102(b)--Implementation (items 2, 3, 4, 5, and 6)--and section 102(c)--Procedures (items 1, 4, 5, and 8)--mention selected facets of these responsibilities and by inference could be construed to support these two points. However, I believe that a more explicit statement of them would clarify the intent.

I also note that patent policies and antitrust regulations referred to in items 4 and 5 in section 102(c) are only two of a number of factors that affect incentives for technology innovation in the public and private sector. Some of the other factors involved are Federal and State regulations, special tax incentives, special Federal revenue sharing, Federal reimbursement to contractors for independent research and development, and pricing or other procurement considerations in Government acquisition of materiel and services. I suggest, therefore, that to avoid a restrictive interpretation of the legislation's intent, additional items be included or items 4 and 5 be

combined into a more general statement encompassing all factors possibly inhibiting or enhancing private sector investment in technology innovation.

TITLE II--SCIENTIFIC AND TECHNOLOGICAL ADVICE IN THE EXECUTIVE OFFICE OF THE PRESIDENT

I am pleased that Title II deals not only with the advisory role to the President but also with executive branch oversight, evaluation, and coordination of Government-wide R&D. I have previously stated that, to supplement the present pluralistic approach, some form of central focus and oversight is needed for evaluation, coordination, budget priority determinations, and overall national policy. This is especially true for R&D efforts that cut across agency lines and issues involving science and technology that transcend agency responsibilities or have international implications.

Federal R&D activities directed toward providing solutions to national domestic problems are dispersed among numerous agencies. The Director of the Office of Science and Technology pointed out in December 1972 that there were seven major program areas of effort--energy, transportation, health, natural resources, education, social systems, and science and technology base--that accounted for about 95 percent of Federal R&D expenditures outside of defense and space, and that each one of these efforts involved four of more major departments and agencies.

In a January 1974 report--"Research and Demonstration Program to Achieve Water Quality Goals: What the Federal Government Needs to Do" (B-166506)--GAO stated that the Environmental Protection Agency, founded in December 1970, had not yet developed a strategy setting forth its R&D goals, objectives, and priorities. The report stated that, based on current funding levels for water pollution R&D, it is doubtful that statutory goals will be achieved within the time period established by the Congress. The report recommended that the Administrator, Evironmental Protection Agency (1) prepare an R&D strategy to meet the 1983 and 1985 goals established by the 1972 amendments to the Federal Water Pollution Control Act, (2) estimate the amount of money needed, and (3) present this information in the Agency's annual report to the Congress. The report also recommended that the Director of OMB participate with the agency in obtaining the full cooperation of all Federal agencies engaged in water pollution R&D and in developing and implementing a national water pollution R&D plan.

A more recent GAO report--"Need For A National Weather Modification Research Program" (B-133202, August 1974)--noted that seven Federal departments and agencies had conducted weather modification research during fiscal year 1974. We observed that for nearly a decade studies of the administration of Federal weather modification research have identified

common problems hindering progress, such as (1) no central authority to direct Federal department efforts, (2) ineffective coordination, and (3) insufficient resources to achieve timely, effective results. Most studies proposed a national program to resolve the problems. Our review of a major research area, the National Hail Research Experiment, supported the results of these studies. We found that a national weather modification research program, administered and maintained by a lead agency, is needed to effectively administrate fragmented Federal weather modification research activities. This program should include goals, priorities, and plans for allocating resources to meet priority objectives.

As I mentioned earlier, we attempted to assess the impact of the President's 1972 message on science and technology on subsequent Federal budgets. A summary of a portion of this study is attached to my testimony. We found that there has been some redirection of priorities. Except for the space shuttle, energy-related R&D, and biomedical research, however, the amounts involved in the redirection of priorities have been relatively small. For example, in the President's 1972 message, he proposed spending 46 percent ($210 million) more in fiscal year 1973 on a variety of projects to develop fast, safe, pollution-free transportation. Although noting that transportation affects

all aspects of society and contributes almost 20 percent of the country's gross national product, the 1974 Special Analyses of the Budget shows only a $64 million increase for fiscal year 1973 transportation R&D. The analysis further states that, with the exception of the airplane, transportation R&D had been an underfunded segment of industry for several decades, and that the Administration's support was increased in 1974 to help overcome past deficiencies. The Special Analyses for fiscal years 1975 and 1976 did not show Government-wide support for transportation R&D in spite of its previously cited importance.

Our interpretation of statements made by OMB and the Science Advisor is that, because of their strong commitment to the pluralistic approach for R&D budget formulation, they tend to treat the examination of crosscutting issues only on a selective basis that may vary from year to year. It is apparent that the total Federal R&D budget, as presented in the Special Analyses, is still an after-the-fact summary analysis which does not adequately assess the overall status of science and technology nor the strategy in relation to national goals.

I believe--and agree with Dr. Stever--that each Federal agency should develop a strategy and priorities for the support and use of R&D to fulfill its mission objectives. In my view, however, this is inadequate. The number and

importance of crosscutting related and overlapping areas of interest of individual agencies make a central focus not only desirable but necessary to insure mutually compatible and coherent R&D programs.

In connection with last year's hearing, I cited instances in which this focus is needed. Because I strongly advocate an annual overall evaluation and status report that reveals the rationale for proposed budget changes, I should like to repeat these instances for emphasis. For example, energy source development and conservation objectives are constrained by environmental protection requirements. Public transportation, crime prevention, law enforcement, and housing and urban development are all mutually interactive and constrained by energy and material shortages as well as environmental concerns. Also, the pressures of inflation and budgetary constraints tend to squeeze the allocations for basic and longer range applied research for which each agency's return on investment is uncertain in both results and time.

There are other issues invoving science and technology that transcend individual Government agencies. Among them are the impact of science and technology on the economy and the environment, the Federal role in assisting State and local governments, Federal intervention in and/or assistance to high technology industry to protect our

industrial base against foreign competition, and Federal assistance to graduate education.

Also, we are now in a transition period wherein the science and technology component of international relations is emerging with ever greater importance. For example, in coping with the energy crisis, dealing with the shortage of critical minerals, and increasing world food supply, it is clear that central oversight needs to be established. Such policy issues are also involved in striking an appropriate balance among protecting technological advantages for military preparedness, fostering international sharing of technological resources to help developing nations, and strengthening negotiations for world peace.

Title II provides for creation of a Council of five advisors. Senate Bill S. 32 provides for a Council of three members. I believe that there are likely to be problems associated with a council-type organization. As I stated in the July 1974 hearings, a multimember council tends to be cumbersome. My recommendation is a single advisor with highly qualified multidisciplinary supporting staff, and with advisory panels representing various fields of science and technology.

The bill provides that the five Council members shall be appointed by the President, with the advice and consent

of the Senate. I endorse the provision for Senate confirmation. The Council (or Advisor) should be responsive to Congress' interests by being able to present testimony and make available to Congress its assessments of the executive branch's science policy and programs. Senate confirmation helps assure this responsiveness.

I note that the bill provides for an annual report on the status of science to be prepared for the President and the Congress. This should have high priority. In conjunction with my testimony last July, I stated that "continued analysis, development, and testing of science indicators along the lines initiated in the 1972 annual report of the National Science Board should help to sharpen our focus and ability to assess our national and international posture in science and technology." I have been advised that an updated report on science indicators is expected to be released in September.

Section 202(4) of the bill states that one of the functions of the Council will be to conduct or have conducted long-range studies, analyses, and plans in regard to the application of science and technology to major national problems or concerns. Undoubtedly, this Council will be very close to the firing line on current issues and will necessarily be involved heavily in matters requiring priority attention by the President. I should like to

suggest that the responsibility for performing and sponsoring longer range policy studies and analyses remain with NSF, presumably with close coupling to and guidance from the science advisor(s) and staff. I would assume that the Foundation would also play a major role in preparing the annual science report. The remaining duties and functions of the Chairman and the Council, as outlined in sections 202 and 203 of the bill are in line with my thinking.

Section 205 provides the President flexibility in the organization and duties of the Council and Chairman, subject only to congressional disapproval. This feature is necessary because, to be effective, the advisory function must be flexible to suit the needs of individual Presidents.

TITLE III--DEPARTMENT OF RESEARCH AND TECHNOLOGY OPERATIONS

The concept embodied in this proposal for a Cabinet-level post is somewhat different from previous proposals for the establishment of a science and technology department. My interpretation of the proposal is that the Secretary's role would be a mix of staff and line responsibilities.

One of the major arguments for this proposal appears to be the aggregation and closer coupling of interrelated broad-objective multidisciplinary science and technology activities that are not primarily or uniquely related to the mission of a single agency or department. At the same time it permits a high degree of freedom and independence

for each of the major elements assigned to the administrative oversight of the Secretary.

Another argument for creating this Cabinet-level post is to identify in a primary point of advice to the President the principal advocacy role for Federal support of basic science and technology. In this sense, this officer's role would be similar to that of any Cabinet head. Except for enlarged jurisdiction, this person would operate under the same handicaps, however, as the Director of the National Science Foundation as the objective arbiter and disinterested advisor on Government-wide science policies.

One can readily perceive some advantages to an arrangement which brings together the National Science Foundation, the National Bureau of Standards, and possibly the research centers of the National Aeronautics and Space Administration. I have some reservations, however, with respect to including the Energy Research and Development Administration and the National Oceanic and Atmospheric Administration under this umbrella. For the most part, ERDA's mission is closely coupled with the Federal Energy Administration and the Department of Interior. For this reason I have previously testified on the high priority need to establish a new Department of Energy and Natural Resources. It is possible, however, that the high energy physics research and certain other long-range or basic research efforts currently

included in ERDA might be more appropriately assigned to NSF. I understand that this matter is under consideration currently. The National Oceanic and Atmospheric Administration, on the other hand, comprises a mix of R&D and closely related service missions which would not seem to fit the concept of the suggested department. Perhaps further study would reveal that there are other basic research, education, or broad-based technology entities which should be included under the type of department proposed in this Title.

Section 303(a)(6) would also establish within the Department a "Science and Technology Information and Utilization Corporation" as further described in Title IV. I support the idea of including an organizational unit designed to foster and promote technology transfer and utilization, closely coupled to the scientific and technological activities. However, I have some reservations about the specific model proposed in Title IV and will comment on that separately.

Section 306 provides that, in the event of unresolved differences between the R&D budget recommendations of the Secretary and the determinations of the Director of OMB, this disagreement must be disclosed to the Congress along with explanatory materials. This is a broad policy question which goes beyond the immediate suggestion. I would

prefer to see the matter considered separately, perhaps as an amendment to the Budget and Accounting Act.

TITLE IV--SCIENCE AND TECHNOLOGY INFORMATION AND UTILIZATION CORPORATION

Title IV would establish a Government corporation to combine a number of science and technology information service elements. Although this might be a step in the right direction, I should like to consider this proposal in the context of a more comprehensive view of technology transfer and use, i.e., the process by which technology advances reach the marketplace and public acceptance.

The Technology Transfer Process

First, the transfer and utilization of scientific results and technology is a complex process and usually involves much more than documentary services, computerized data banks, and the dissemination through publications of technical information. In particular, as pointed out in GAO's report, "Means For Increasing The Use Of Defense Technology For Urgent Public Problems" (B-175132, December 29, 1972), it requires active people-to-people communications to bring technology developers together with potential users, and often involves third party agents or "technology brokers" to help bridge the communication gap. This is especially true when the developer and potential user do not have similar technical backgrounds and when the commonality of problems is not obvious.

That report dealt primarily with only one facet of this problem; namely, how to enhance the sharing of scientific and technological resources between and among Federal agencies and, in particular, how to overcome some of the barriers that inhibit the sharing of defense technology with Federal civil agencies.

We pointed out, however, that many civilian applications of defense technology have resulted in private sector development, primarily defense industrial contractors. We also pointed out that, to a large extent, the potential markets for technology which can be applied to solving urgent sociological problems have not developed. Generally, defense and aerospace contractors have been unable to deal effectively with these ill-defined and fragmented markets. It has become necessary, therefore, for the Federal Government to support these programs directly.

The Federal Role in Public Technology Innovation

Now let us consider what is or should be the role of the Federal Government, especially civil agencies, and how the Federal partnerships with State and local governments, industry, and academic institutions can be improved to enhance public technology advancements.

Industrial growth and productivity and the economy can be stimulated by special tax incentives, enlightened patent policy, selective relaxation of adverse Government

regulations, and in many other ways. Such assistance is important when market forces are inadequate or when the existence of externalities (benefits accruing to others than the primary investor) or high risk preclude adequate private investment. But such stimuli alone generally will not motivate industry to invest its own resources to meet the technological needs of public institutions. This is especially true when the public market for technological products and services is latent, fragmented, or intractable because of political, parochial, and jurisdictional constraints. Such factors, as well as economic limitations, greatly impede the acceptance of technological innovations by public institutions.

The primary role of Federal civil agencies in technological leadership, therefore, can be one of leadership and providing incentives to others, including private industry. The Federal role involves:

(1) Identifying problems and potential solutions,

(2) Adapting existing technology or sponsoring R&D,

(3) Demonstrating the feasibility of technological improvements,

(4) Establishing performance standards,

(5) Removing barriers to acceptance at State and local levels,

(6) Employing regulatory authority, and

(7) Subsidizing the transition or providing special incentives until the potential for aggregated markets and economies of scale create sufficient motivation for the private sector to invest its own capital.

To be most effective, the Federal agencies must establish better working partnerships with State and local governments and the private sector. Since industrial resources are needed to produce goods for use by public institutions in improving the quality of their services, it is desirable to involve industrial contractors in the early phases of R&D, adaptive engineering, and demonstration.

Recent Studies and Experiments in Technology Innovation

Much more needs to be learned about public technology innovation, i.e., the process of not only generating technological options but also fostering the selective adaptation, transfer, and use to benefit both the economy and the quality of life. Even so, we have certainly learned enough to realize that the Federal Government's leadership role in the technology delivery system needs to be improved.

In recent years, a number of studies and experiments have been performed or sponsored by Federal agencies from which lessons are being learned about the process. Notable examples are the NASA technology utilization program; the Housing and Urban Development's "Operation Breakthrough" program; the NSF intergovernmental science, R&D assessment,

and experimental R&D incentives programs; and the NBS experimental technology incentives program. These efforts include experiments in active technology transfer methods and institutional arrangements, Federal procurement leverage, and aggregation of markets common to a number of cities. Experience gained by the Federal Laboratory Consortium for Technology Transfer is also relevant. This consortium was initiated by a group of defense laboratories but has now expanded to include representatives from other agencies, coordinated through the National Science Foundation.

Two recent reports ("Barriers to Innovation in Industry: Opportunities for Public Policy Changes," September 1973, by Arthur D. Little, Inc., and "Technology Transfer and Utilization," February 1974, by the National Academy of Engineering) resulting from NSF-sponsored studies on this subject should be most helpful.

I believe the model proposed in Title IV is too limited in that it is primarily concerned with passive information services. I, therefore, recommend a review and critique of past and ongoing federally sponsored studies and experiments to ascertain what lessons have been learned which could provide the basis for an improved model of a federally sponsored technology delivery system.

THE ADMINISTRATION BILL

Mr. Chairman, in addition to H.R. 4461, you have asked me to comment on the Administration bill. The Administration

bill would establish an Office of Science and Technology Policy in the Executive Office of the President. The Director would be appointed by the President and also serve as his Chief Policy Advisor with respect to scientific and technological matters. Although not explicitly stated in the bill, we learned from Dr. Stever's testimony on June 10 that the Director would also serve as Chairman of the Federal Council for Science and Technology. This arrangement appears to be very similar to the former Office of Science and Technology in both structure and assigned functions.

The bill authorizes staff as deemed necessary to perfrom assigned functions. The Director also would be authorized to draw upon resources from other Government agencies or to contract for studies and consulting services. The intent is to keep the number of permanent staff small and to draw heavily upon other resources, including ad hoc panels involving representatives from both within and outside the Federal Government. The Office would be concerned not only with domestic matters but also with military and international relations.

I believe this proposal is workable. As I have previously stated, I prefer the selection of a single individual as the Science Advisor and believe that this Office should be established by statute. However, I would favor

requiring the Director and Deputy Director to be appointed by the President and confirmed by the Senate. Such confirmation is not now provided for in the Administration bill.

The question of congressional access to the Science Advisor for testimony continues to be a sensitive matter. I believe the President should be allowed the protection of executive privilege with respect to specific advice and conversation between him and the Science Advisor; but I also believe that any person of sufficient stature to hold the position would also be able to exercise discretion in sharing with the members of Congress his views on many matters involving science and technology, without violating his loyalty with respect to private Presidential conversations. Hence, I would prefer to see the legislation specify that the Congress reserves the right to call upon the Director and/or his staff, perhaps with the Office hat on rather than the personal advisor hat. I note also that the bill does not call for an annual status report on science and technology as provided in H.R. 4461. I believe such a provision should be added.

SUMMARY

In summary, I recommend that the Congress establish by statute the means of providing a comprehensive policy for science and technology in relation to national goals and priorities. Furthermore, I generally support the statements

presented in Title I subject to the revisions noted relating primarily to the Federal role in accelerating the application of technology for national needs.

I also support the establishment by statute within the Executive Office of the President of a flexibly structured advisory and Government-wide oversight unit for science and technology (Title II). I am especially pleased that this office would prepare an annual report to the President and the Congress assessing progress against science and technology goals.

Although there are a number of potential advantages to the establishment of a Department of Research and Technology Operations, as proposed in Title III, I doubt if this is a necessary supplement to a science advisor in the Executive Office of the President and would hope the proposal could receive further study and be considered separately.

I believe the Federal leadership role in fostering public technology innovation needs to be better defined and perhaps a special organizational unit established for this purpose. However, I think the model proposed in Title IV is too limited in that, in primarily emphasizing information services, it may not be very effective.

A supplementary statement of administrative and technical comments on various provisions of H.R. 4461 will be provided separately.

This concludes my statement, Mr. Chairman. We will be happy to answer any questions you may have.

Attachment

ATTACHMENT

EXAMINATION OF FEDERAL STRATEGY FOR CIVILIAN R&D

The need to develop strategies for civilian R&D has become more evident during the past 10 years because the Government has been shifting its budgetary priorities from defense and space to domestic programs.[1/] The proportion of Federal outlays for defense and space decreased from 52.7 percent of total outlays in 1965 to an estimated 38 percent in 1974.

NSF statistics show that defense-related R&D was 32.3 percent of the national total in 1965 and an estimated 28.9 percent in 1974; Federal nondefense-nonspace R&D was 11.1 percent in 1965 and an estimated 15.2 percent in 1974. Statistics indicate an overall shift of about 3 to 4 percent between the two categories. Federal space-related R&D decreased from 20.4 percent in 1965 to an estimated 9.0 percent in 1974 producing a net decrease of about 11 percent in Federal support for national R&D during the period.

In 1971, the President directed his Domestic Council to examine new technology opportunities in relation to domestic problems. Letters were sent to Government agencies asking for their technology proposals. The technological merit of the proposals were assessed and evaluated on how they might contribute to solving critical domestic problems, improving the competitive position of the United States in world trade, and using the skills of unemployed scientists and engineers. Later, letters were sent to trade associations and to individual companies in private industry soliciting their proposals.

As a result of the solicitations, Federal agencies submitted proposals that reportedly could have cost $1.5 billion in fiscal year 1973, increasing to $11 billion through

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[1]Murray L. Weidenbaum, "Government Spending and Innovation," Astronautics and Aeronautics, Nov. 1973, pp. 32-43, reports that as a result of updating priorities, Federal support for R&D has been curtailed without the Government making such a decision consciously.

fiscal year 1977. Industry also submitted numerous ideas. In the end, however, none of the large-scale proposals was accepted.

In September 1971, during the Domestic Council's search for new technology opportunities, the President announced[1] that in the next session of the Congress he would present "new programs to insure the maximum enlistment of America's technology in meeting the challenges of peace." The President's special message to the Congress on science and technology, dated March 16, 1972, called for a strong new effort to marshal science and technology to strengthen the economy and improve the quality of life.

The President's special message reported the development of an overall strategic approach in allocating Federal scientific and technological resources. Six elements of the new Federal strategy along with subsequent budgetary actions are discussed below.

STRENGTHENING THE FEDERAL ROLE

> "My recommendations for strengthening the Federal role in science and technology have been presented to the Congress in my State of the Union message, in my budget for fiscal year 1973, and in individual agency presentations. I urge the Congress to support the various elements of this new Federal strategy."

Reorientation of space program

> "1) We are reorienting our space program to focus on domestic needs--such as communications, weather forecasting and natural resource exploration. One important way of doing this is by designing and developing a reusable space shuttle, a step which would allow us to seize new opportunities in space with higher reliability at lower costs."

A review of the National Aeronautics and Space Administration's budget plan summaries shows substantial increases

[1]Address to the Congress on Stabilization of the Economy, Sept. 9, 1971.

in the development of a space shuttle, but major decreases in space applications dealing with communications, weather forecasting, and natural resources exploration.

	1972	1973	1974	1975
	(000 omitted)			
MANNED SPACE FLIGHT:				
Space shuttle	$ 100,000	$ 198,600	$ 475,000	$ 800,000
Other	1,185,500	937,200	581,500	324,800
Total	1,285,500	1,135,800	1,056,500	1,124,800
SPACE APPLICATIONS:				
Weather and climate	45,500	60,300	51,100	35,000
Earth resources survey	74,700	55,200	47,400	58,600
Communications	59,800	58,100	22,100	8,300
Other	7,500	15,100	40,400	75,600
Total	187,500	188,700	161,000	177,500
Total	$1,473,000	$1,324,500	$1,217,500	$1,302,300

The largest decrease in space applications has been in communications. OMB officials told us that as a result of overall budget constraints, the level of technology development, and the economic viability of the communications industry, the National Aeronautics and Space Administration has been turning much of its communication satellite work over to private industry. The "other" space applications which have had large increases in the 1972-75 timeframe include earth and ocean physics and pollution monitoring.

Selected civilian R&D targets

> "2) We are moving to set and meet certain civilian research and development targets. In my State of the Union Message, my Budget Message and in other communications with the Congress, I have identified a number of areas where new efforts are most likely to produce significant progress and help us meet pressing domestic needs. They include:
>
> New sources of energy
>
> "--Providing new sources of energy without pollution. My proposed budget for fiscal year 1973 would increase energy related research and development expenditures by 22 percent."

The program to develop new sources of energy without pollution was superseded by a stepped-up program to achieve self-sufficiency in energy production, referred to as Project Independence. The administration proposes to spend $10 billion over a 5-year period beginning with fiscal year 1975, to encourage and complement, but not supplant, a vigorous R&D effort by private industry.

Millions of dollars obligated, actual and estimated, by more than six major departments and agencies are reported to be:

	1972	1973	1974	1975
Fed. Energy R&D Program	$537.0	$672.2	$999.1	$1,815.5

Transportation R&D

> "--Developing fast, safe, pollution-free transportation. I have proposed spending 46 percent more in the coming fiscal year on a variety of transportation projects."

In support of the above statement, OMB's Budget in Brief for 1973 reported a Government-wide increase of $210 million to provide fast, safe, and pollution-free transportation. However, OMB's 1974 Special Analyses reported an estimated Government-wide increase of only $64 million for fiscal year 1973. A comparison of these conflicting reports is shown below:

			Increase	
	1972	1973	Amount	Percent
	(millions)			
Budget in Brief--1973	$456	$666	210	46
Special Analyses--1974	602	666	64	11

The 1974 Special Analyses reported that transportation affects all aspects of society and contributes almost 20 percent of the country's gross national product (GNP). The Analyses stated that with the exception of the airplane, transportation R&D had been an underfunded segment of industry for several decades, and that the administration's support was increased to $749 million in 1974 to help overcome past deficiencies.

The 1975 Special Analyses does not show Government-wide support of transportation R&D in spite of its previously cited importance. The Analyses, however, reports that R&D obligations for the Department of Transportation, including facilities, is expected to increase from $390 million in 1974 to a projected $417 million in 1975. This increase of about 7 percent is expected to maintain the thrust of transportation R&D.

Summary data as reported in OMB's Special Analyses for 1974 and 1975 and other budget documents show the following amounts and trends:

Transportation R&D

	1972 actual	1973 actual	1974 est.	1975 est.	Percent increase for 1972-75
	(millions)				
DEPT. OR AGENCY:					
National Aeronautics and Space Administration, aeronautical research and technology	$109	$151	$168	$166	52
Department of Transportation R&D	351	311	358	396	13
Commerce, maritime R&D	23	24	25	28	22
Department of Defense (note a)	-	-	-	-	-
Total	$483	$486	$551	$590	22%

[a]Although the Department of Defense performs R&D that has secondary benefits for civil transportation, we did not undertake the detailed analysis required to identify this effort.

Applying an inflation factor to the above amounts over the 4-year period not only offsets the total increase of 22 percent but shows a small decrease in total R&D effort. Only the National Aeronautics and Space Administration aeronautical R&D program exceeded the inflationary

factor indicating that with the exception of the airplane, transportation R&D continues to be an underfunded segment of industry, as noted in the 1974 Special Analyses.

Natural disasters

"--Working to reduce the loss of life and property from natural disasters. I have asked, for example, that our earthquake research program be doubled and that our hurricane research efforts be increased."

The 1973 Special Analyses reported an increase of $43 million for R&D to improve capabilities to control, predict, or reduce destruction from fires, earthquakes, floods, hurricanes, and severe storms. The 1973 Budget in Brief showed:

	1972	1973	Percent increase
	(millions)		
Reduction in loss of human life and property from natural disasters	$93	$136	46

The following year the 1974 Special Analyses reported that research efforts to decrease the loss of lives and property from severe storms and fires would be increased. Attention would continue to be focused on research on severe storms, such as hurricanes, tornadoes, and hail, and greater effort would be maintained in earthquake engineering and prediction. However, as shown below, the 1974 Analyses reported substantially smaller amounts for 1972 and 1973 than reported in the 1973 Analyses.

	1972 actual	1973 est.
	(millions)	
Reduce loss of lives and property from natural disasters	$36	$48

Although we could not reconcile the above differences, our analysis of Federal funding related to the objective of reducing losses from natural disasters showed:

	Budget authority			
	1972 actual	1973 actual	1974 est.	1975 est.
	(millions)			
Observe and predict weather, ocean conditions, and disturbances	$146	$145	$151	$151
Weather modification research	18	18	21	22
Total	$164	$163	$172	$173

The 1974 and 1975 Special Analyses report that 11 major departments and agencies annually expend $400 to $500 million in R&D activities to understand, describe, and predict environmental conditions from fiscal years 1972 through 1975. The amounts shown in the above schedule are reported as part of this total Federal R&D effort and include such activities as earthquake research. Although the Special Analyses do not provide a breakdown of the Federal activities by agency programs and amounts, the NSF budgetary data show that its earthquake research increased from about $2.9 million in 1972 to $8.0 million in 1975.

Use of GNP deflators shows that the budget allocations have been continually decreasing on a constant dollar basis, as follows:

	1972 actual	1973 adjusted	1974 adjusted	1975 adjusted
	(millions)			
Budget authority	$164	$154	$149	$139

Drug abuse R&D

"* * *Improving drug abuse rehabilitation programs and efforts to curb drug trafficking. Our budget requests in this critical area are four times the level of 1971."

The 1974 and 1975 Special Analyses report the following estimated Federal obligations for fiscal year 1972 and outlays for fiscal years 1973 through 1975.

Drug Abuse Prevention Program:	1972	1973	1974	1975
	(millions)			
Research, planning and evaluation	$ 51.4	$ 52.2	$ 77.9	$ 73.9
Treatment and rehabilitation	142.6	147.0	226.7	240.9
Education and training	45.3	39.1	40.9	39.4
Other drug abuse prevention activities (note a)	129.2	126.4	99.7	106.4
Total	$368.5	$364.7	$445.2	$460.2

[a]Federal funds available for non-Federal drug abuse activities through financing and bloc grant programs.

The above schedule shows that the major expenditures and increases have been for treatment and rehabilitation. These activities accounted for about 39 percent of available funds in 1972 and increased to about 52 percent in 1975. Research, planning, and evaluation accounted for approximately 15 percent of available funds in each year from 1972 through 1975.

The above outlays are in addition to law enforcement activities which increased from $194 million in 1973 to $245 million in 1974 and $293 million in 1975.

Biomedical research and health care

> " * * * Increasing biomedical research efforts especially those concerning cancer and heart disease, and generally providing more efficient and effective health care, including better emergency health care systems."

OMB's Special Analyses report that Federal outlays for biomedical research increased from $1,776 million in fiscal year 1972 to an estimated $2,587 million in 1975--an increase of about 46 percent. Federal outlays for cancer research

increased from $255 million in 1972 to $459 million in 1975 and for cardiovascular research from $166 million in 1972 to $432 million in 1975, as shown below.

Research category	1972 actual	1973 actual	1974 estimated	1975 estimated
	(millions)			
Cancer	$ 255	$ 353	$ 456	$ 459
Cardiovascular	166	329	389	432

Concerning the provision for more efficient and effective health care, NSF reports the following data.

Delivery of Health Care
Federal R&D Obligations

1971 actual	1972 actual	1973 actual	1974 estimated	1975 estimated
		(millions)		
$122.2	$113.4	$81.8	$86.5	$83.2

In noting the substantial decrease since 1971, NSF reported the chief factors in 1974 were reductions in the Department of Health, Education, and Welfare's National Center for Health Services R&D and Center for Disease Control and the phaseout of the Health and Nutrition program of the Office of Economic Opportunity.

In commenting on 1975 programs, NSF reports that delivery of health care includes a number of research programs with widely differing purposes. The largest is the health services research and evaluation program of the Department of Health, Education, and Welfare's Health Resources Administration, which is scheduled in 1975 for a large decrease from $55 to $49 million.

Department officials told us that approximately $20.8 million has been spent on demonstrating emergency health care systems from 1972 through 1974, as follows:

Emergency health care systems:	1972	1973	1974
		(millions)	
Demonstration projects	$7,900	$ 500	$ 7,150
Communication subsystems	-	1,000	850
Research contracts and grants	100	-	3,300
Total	$8,000	$1,500	$11,300

The officials estimate about $4.5 million for research in fiscal year 1975 under the Emergency Medical Services System Act of 1973.

Use of high technology agencies

> "3) We will also draw more directly on the capabilities of our high technology agencies--the Atomic Energy Commission, the National Aeronautics and Space Administration and the National Bureau of Standards in the Department of Commerce--in applying research and development to domestic problems."

The objective was to use the high technology agencies' capabilities, primarily on a reimbursable basis, to deal with domestic problems and meet long-range goals without diverting them from their primary missions. The three agencies' reimbursements, excluding those from the Department of Defense, have been:

	1972 actual	1973 actual	1974 actual	1975 estimated
		(millions)		
AEC	(a)	$ 51.3	$ 46.4	$ 42.6
NASA	$ 54.5	75.9	[b]174.3	[b]144.9
NBS	24.9	25.5	29.3	34.5
Total	$ -	$152.7	$250.0	$222.0

[a]Not available.

[b]Major increases have been in space vehicle procurement for unmanned missions, as follows:

Space Vehicle Procurement and Related Items

	1972	1973	1974	1975
	(millions)			
Civil agencies	$16	$14	$ 11	$ 30
Non-Federal sources	35	43	127	91
Total	$51	$57	$138	$121

Federal standards and regulations

> "4) We are making strong efforts to improve the scientific and technological basis for setting Federal standards and regulations. For example, by learning to measure more precisely the level of air pollution and its effects on our health, we can do a more effective job of setting pollution standards and of enforcing those standards once they are established."

The President, in his budget for fiscal year 1973, requested $76.1 million for the National Bureau of Standards (NBS) research and technical services. This was an increase of about $28 million, or 60 percent, over the adjusted appropriation for 1972. The proposed budgetary expansion was for programs attacking national problems of unusual magnitude--including the declining rate of growth of U.S. productivity and the first balance of trade deficit in this century, environmental pollution, and public safety.

The budgetary actions related to the 1973 request and subsequent requests are shown below:

NBS Budgetary Data--FY 1972-75

Fiscal year	Budget request	Amount appropriated	Total adjustments increase or decrease (-) (note a)	Adjusted appropriation
		(millions)		
1972	$-	$-	$-	$47.7
1973	76.1	69.4	-13.4	[b]56.0
1974	[c]57.7	[c]56.7	.2	56.9
1975	[c]62.6	-	-	-

[a]Program reductions and deferrals, other adjustments to base, and built-in changes.
[b]Includes $7 million for new Experimental Technology Incentives Program.
[c]Amounts adjusted to exclude previous years' carryovers.

When adjusted appropriations are further adjusted for the effects of inflation, the amounts show no real growth. Consequently, to the extent that NBS is making stronger efforts to improve the scientific and technology base for setting Federal standards and regulations, it is doing so by redirection of priorities rather than by increased budgets. For example, the Environmental Pollution Abatement Program has grown from a fiscal year-1972-adjusted appropriation of $909,000 to a fiscal year-1975 request for $4,080,000.

In addition to NBS, the R&D activities within the Environmental Protection Agency deal with causes, sources, transport, fate, and effects of pollutants in ecological systems; and development of monitoring technology and pollution control criteria used in establishing standards

and regulations. The Protection Agency reports the following R&D budgetary data:

Environmental Protection Agency R&D
FY 1972-1975 Budget Authority

	1972 actual	1973 actual	1974 actual	1975 estimated
	(000 omitted)			
Processes and effects	$ 73,695	$ 72,856	$ 71,944	$163,994
Control technology	101,454	88,912	64,500	173,412
Management and support	-	15,103	16,199	19,663
Total	$175,149	$176,871	$152,643	$357,069

The sizable increase in 1975 is largely attributable to a $179,000,000 increase in energy R&D. The amounts of R&D used for developing criteria and guidelines for standards and regulations are:

1973 actual	1974 actual	1975 estimated
(000 omitted)		
$25,964	$29,850	$37,154

The 1972 amounts were not available.

After studying the Protection Agency's R&D activities an ad hoc committee from the National Academy of Sciences concluded that the Agency's research management system is seriously defective. The committee's report points out that priorities do not reflect the needs of regulatory and regional offices, and that no long-term program for meeting stated goals has been devised.

R&D in colleges and universities

> "5) I am also providing in my 1973 budget for a 12 percent increase for research and development conducted at universities and colleges. This increase reflects the effort of the past 2

years to encourage educational institutions to undertake research related to important national problems."

OMB's Special Analyses of its fiscal year 1973 budget reported a 12-percent increase between the amount of estimated obligations for 1972 ($2,020 million) and the amount estimated for 1973 ($2,257 million). In the following year, however, the Special Analyses showed an estimated increase of only 2 percent based on actual obligations for 1972 ($1,868 million) and estimated obligations for 1973 ($1,907 million).

The Special Analyses for fiscal year 1975 does not show actual or estimated obligations for R&D in colleges and universities from 1973 through 1975. Instead it compares actual and estimated expenditures for fiscal years 1973, 1974, and 1975, which differ from expenditures reported in 1974 for comparable years, as shown below:

R&D in Colleges and Universities

Expenditures

	1972 actual	1973 actual	1974 est.	1975 est.
	(millions)			
Special Analyses, 1974	$1,671	[a]$1,750	$1,836	-
Special Analyses, 1975	-	[b] 1,888	2,107	$2,262

[a]Estimated.
[b]Actual.

NSF support of industrial applied research

"6) Finally, I believe that the National Science Foundation should draw on all sectors of the scientific and technological community in working to meet significant domestic challenges. To this end, I am taking action to permit the Foundation to support applied research in industry when the use of industrial capabilities would be advantageous in accomplishing the Foundation's objectives."

In the spring of 1972, the President of the United States delegated to the Director of NSF authority to support applied research at institutions for profit when such research was relevant to national problems involving the public interest, as otherwise provided for in the 1968 amendments to the NSF Act. The 1968 amendments resulted in establishing NSF's Research Applied to National Needs program in fiscal year 1971.

The National Needs program has increased from about $70 million in 1973 to an estimated $149 million in 1975. The increase has been due to energy-related research. For example in 1974, the National Needs program spent a total of about $93 million with nonenergy research limited to $47 million. For 1975, the Congress has voted a $50 million limit on National Needs research not related to energy.

NSF's statistics on percentage distribution of National Needs funds by performers show that industry's share has increased from about 6.1 percent in 1973 to an estimated 25.6 percent in 1975. The Assistant Director for Research Applications, NSF, testified that this substantial increase directly reflects the increasing involvement of industry in the energy program and also the increasing emphasis on exploratory applications.

STIMULATION OF NON-FEDERAL R&D

The President's special message on science and technology in March 1972 also called for new actions, relationships, and legislation designed to enhance R&D in all sectors--State and local governments, universities and private industry--with the Federal Government playing a catalytic role wherever possible. The President's Economic Report to the Congress, January 27, 1972, had previously pointed out that the Federal Government's involvement was necessary to prevent a national underinvestment in R&D, and that recent developments had raised serious questions about the adequacy of the Nation's R&D program.

The special message, however, noted that the processes by which the Federal Government could stimulate non-Federal investment in R&D were not well known or understood. For this reason, an R&D assessment program was initiated in

fiscal year 1973 to help improve the Government's understanding of the innovation and research application process. R&D experimental programs were also initiated to explore ways to stimulate R&D investments and applications by private firms and other non-Federal institutions.

Experimental R&D incentives programs

In his special message the President explained the new experimental programs as follows:

> "I have requested in my proposed budget for fiscal year 1973 that new programs be set up by the National Science Foundation and the National Bureau of Standards to determine effective ways of stimulating non-Federal investment in research and development and of improving the application of research and development results. The experiments to be set up under this program are designed to test a variety of partnership arrangements among the various levels of government, private firms and universities. They would include the exploration of new arrangements for cost-sharing, patent licensing, and research support, as well as the testing of incentives for industrial research associations."

Although more than $36 million was proposed in the 1973 budgets of NSF and NBS for the experimental incentives program, only the following amounts were actually available for obligations:

	1973	1974	1975 requests	Total
	(millions)			
NSF experimental R&D incentives program	$15.0	$10.0	$1.0	$26.0
NBS experimental technology incentives program	7.0	3.2	.8	11.0
Total	$22.0	$13.2	$1.8	$37.0

About $29 million was appropriated for the two experimental programs for fiscal year 1973 but about $7 million was subsequently impounded. The NSF program which experimented with new roles was curtailed in fiscal year 1975. Officials in OMB said that they thought the program was getting too academic. The program is now being reevaluated and reorganized under the NSF's Research Applied to National Needs program.

The NBS program, on the other hand, is just getting started. The program is experimenting with removing barriers to innovations that have developed from the Federal Government's traditional ways of governing and doing business. It will have about $7 million to obligate during fiscal year 1975; over $6 million is being carried over from previous years because of the program's slow start.

R&D assessment program

The President explained the need for the assessment program as follows:

> "I believe we need to be better informed about the full consequences of all such policies for scientific and technological progress. For this reason, I have included in my budget for the coming fiscal year a program whereby the National Science Foundation would support assessments and studies focused specifically on barriers to technological innovation and on the consequences of adopting alternative Federal policies which would reduce or eliminate these barriers. These studies would be undertaken in close consultation with the Executive Office of the President, the Department of Commerce and other concerned departments and agencies so that the results can be most expeditiously considered as further Government decisions are made."

those reported in the 1973 documents. The 1975 documents did not report either the past expenditures or the current budget requests for the civilian R&D targets cited for priority treatment in previous documents.

Our study of budget documents showed that there has been some redirection of priorities within generally declining R&D budget allocations. Except for the space shuttle, energy-related R&D and biomedical research, however, the amounts involved in the redirection of priorities have been relatively small.

Although the President had requested about $39 million for the new assessment and experimental programs to study and explore ways to stimulate non-Federal R&D investments and applications in fiscal year 1973, this level of effort was never realized. Our review of subsequent budgetary actions shows that about $31 million was appropriated for fiscal year 1973 of which about $24 million was made available for obligations. An additional $15 million was made available for obligations in fiscal year 1974, and due to program reassessment and slow starts, about $5 million was requested for fiscal year 1975. (See pp. 16 and 18.)

Since fiscal year 1972, the major increases in Federal R&D effort have been in the energy and environmental categories. NSF reports that the largest program in the environmental category, and the one responsible for the sharp growth of the environmental function in 1975, is a group of energy-related programs sponsored by the Environmental Protection Agency. (Note comments on p. 13.) In spite of the increases there has been a 5 percent net decrease in the Federal R&D effort from 1972 through 1975, as shown below.

Federal R&D Obligations by Function: 1972-75

on Basis of 1972 Constant Dollars Using GNP Deflators (note a)

Function:	1972	1973	1974 (est.)	1975 (est.)	Diff. from 1972-75
			(millions)		
National defense	$ 8,898,	$ 8,520	$ 7,938	$ 8,179	$-719
Space	2,714	2,464	2,170	2,037	-677
Health	1,564	1,508	1,803	1,574	10
Energy development and conversion	383	419	497	800	417
Environment	547	642	638	785	238
Science and technology base	606	577	559	610	4
Natural resources	625	585	546	593	-32
Transportation and communications	617	592	596	566	-51
Education	208	219	197	169	-39
Income security and social services	115	142	113	105	-10
Area and community development and housing	102	111	109	104	2
Economic growth and productivity	78	86	101	90	12
Crime prevention and control	25	33	45	44	19
International cooperation and development	30	31	30	33	3
Total	$16,512	$15,929	$15,342	$15,689	$-823

[a]Deflators derived from current GNP factors in use by the National Science Foundation. The factor for 1975 is a preliminary estimate based on 8 percent increase over 1974.

The above classifications of Federal R&D obligations differ from OMB budget classifications, including the Special Analyses, because each is designed to serve different planning and reporting purposes. NSF developed the above classifications on the basis of what it thinks are the primary or main purposes for the proposed R&D obligations. R&D may, of course, have numerous secondary benefits or effects which cannot be shown without including their dollar amounts two or more times.

Officials at OMB stated that there are no management objectives or criteria for measuring whether the Administration has lived up to the intent of the message. They felt that increased Federal funding was not the primary issue; that the message tended to overstate the Government's intentions to intervene in the private sector; and that conditions have changed since the message was prepared. The officials point out that, since 1972, industry has increased its investment in R&D. Available survey data indicates that this is largely due to industry's increased emphasis on energy-related R&D.