THE NATIONAL SCIENCE FOUNDATION

HEARINGS

BEFORE THE

SUBCOMMITTEE ON SCIENCE

OF THE

COMMITTEE ON

SCIENCE, SPACE, AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

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CONTENTS

WITNESSES

APPENDICES

THE NATIONAL SCIENCE FOUNDATION

TUESDAY, FEBRUARY 25, 1992

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
SUBCOMMITTEE ON SCIENCE,
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:35 a.m. in room 2318, Rayburn House Office Building, Hon. Rick Boucher [chairman of the subcommittee] presiding.

Mr. BOUCHER. This is the first of two days of hearings that the subcommittee will hold on the National Science Foundation's budget request for fiscal year 1993. Today we will hear from representatives of professional science societies and from academe, and next week we will receive testimony from the National Science Foundation.

The fiscal year 1993 budget request for the NSF is 18 percent above the fiscal year 1992 appropriation level. Due to accounting changes associated with logistics support activities for the Antarctic program, the effective increase above the fiscal year 1992 funding level for NSF's programs is 13 percent. The proposed increase reflects the ongoing commitment to doubling the NSF budget by fiscal year 1994, using fiscal year 1987 as the base year.

The growth that is provided by the NSF budget request will allow the Foundation to address a range of research opportunities, including interagency initiatives in four key areas: global change research, high-performance computing, biotechnology, and advanced materials and processing.

The NSF also proposes additional research activities that are focused on advanced manufacturing in the computer sciences, engineering, math and physical sciences, and the social sciences. Much of the budget increase for these wide- ranging research activities will result in increased support for individual investigator and small group awards.

We have asked our first two panels of witnesses today to consider the broad priorities reflected in the NSF's budget request. As I indicated, four interagency research activities that are coordinated by the Office of Science and Technology Policy are a prominent part of the budget. In fact, over 40 percent of the research directorates' budgets are programmed for these initiatives.

We are interested in the views of our witnesses on the wisdom of that allocation, on the advantages and disadvantages of the interagency initiative process, and on whether this process holds the promise of becoming an effective mechanism for the setting of priorities within the Federal research budget.

A second issue associated with budget priorities which we intend to address this morning is the allocation of resources by NSF for research facilities. As was the case last year, the NSF has not requested support for the Academic Research Facilities Modernization Program, which has been funded during the past three years at the approximate level of $20 million each year.

The NSF does request $33 million for the academic research instrumentation program and an increase of approximately $75 million for new construction and upgrades of national research facilities operated directly by the National Science Foundation. The national research facilities receiving increases include new optical telescopes, upgrades to the research ship fleet, and construction of the Laser Interferometer Gravitational Wave Observatory.

We invite our witnesses to comment on both the appropriateness of the priorities for research facilities that are presented in this budget request and also the extent to which the research community is aware of, and participates in, the process for allocation of resources for facilities construction among the range of possible projects and programs.

Our final panel of witnesses today has been asked to concentrate their comments on NSF plans and programs in science education. The Education and Human Resources Directorate budget, largely through congressional insistence, has grown rapidly over the past few years, more than doubling in size since fiscal year 1990. We are particularly interested in assessments of the effectiveness of NSF's management of this program growth.

One recent program thrust by NSF has been the Statewide Systemic Initiative, which will attempt to make systemwide improvements in science and math education at a number of States. Two of our witnesses will discuss program goals and the implementation process for that initiative.

I would like to extend the welcome of the subcommittee to our witnesses this morning, and before calling upon them, we will have statements from other subcommittee members.

The Chair would first recognize the ranking Republican member of the subcommittee, the gentleman from California, Mr. Packard.

Mr. PACKARD. Thank you very much, Mr. Chairman.

I am very pleased with the increase of almost 18 percent in the President's fiscal year 1993 budget for the National Science Foundation. The link between NSF-funded research and the knowledge and technological innovations that flow from such basic research is undeniable.

The National Science Foundation excels not only in supporting outstanding science endeavors but, also, in its dedication to improved science and mathematics education at all levels from kindergarten through graduate school.

This hearing gives us a unique opportunity to examine, from the perspective of outside witnesses, the management of the Education and Human Resources Directorate, which has seen such phenomenal success and growth in the past few years.

We also want to look at how funding for the FCCSET initiatives is impacting the core programs at the National Science Foundation. Another area of interest will be the process of priority setting among the construction of new national facilities, renovation of existing national facilities, and, of course, the renovation of academic research facilities.

I, too, wish to join with you in welcoming our witnesses. I would like to especially welcome Dr. Rowland, who comes from my neighboring district. I do not include all of Irvine, but I go to Irvine, and so I am very grateful that he is here with us to testify today. But to all of the witnesses, we are grateful for your preparation and for your attendance, and I look forward to some interesting dialogue on the issues that we have outlined.

Thank you very much, Mr. Chairman.

Mr. BOUCHER. The Chair thanks the gentleman and recognizes the gentleman from Florida, Mr. Bacchus.

Mr. BACCHUS. Thank you, Mr. Chairman.

I would like to begin by congratulating you on the fine job, the excellent job, you have done in chairing this subcommittee. You have really done a decade's work in one year, and I am proud to be a member of the subcommittee and to work with you.

I very strongly support the Administration's request for a significant increase in the budget for the National Science Foundation. This is one issue on which the Administration has made a commitment and has kept it, and I want to applaud them for doing so. I will continue to support them. I only wish that it could be more.

I want to apologize to these witnesses because I have to leave in a few moments to go downstairs to where I will sit on the Banking Committee and listen as the Resolution Trust Corporation asks for another $55 billion. It worries me that we have to make some very difficult decisions in this subcommittee and other subcommittees of this committee. Do we want to improve laboratory facilities, or do we want to build more laboratory facilities? Obviously, we should do both, but sometimes in the past year we have had to deliberate on difficult choices.

We ought to keep in mind the $3 billion that the administration is asking for for NSF in light of the $55 billion that is being asked for downstairs. Our priorities are not right in this Nation.

On a personal note, I would like to welcome Dr. Gordon Nelson from my district, a constituent of mine, a friend of mine. He does a wonderful job at the Florida Institute of Technology and, of course, is a national leader in his field. I look forward to your testimony.

Also, another friend of mine, Jack Leppert, is here from Florida, from Tallahassee, who works for the Department of Education in the Systemic Initiative. We are very proud of the role that Florida is playing in pursuing this project. We think it will make a difference for the country and for our future.

Thank you, Mr. Chairman.

Mr. BOUCHER. The Chair thanks the gentleman, particularly, for his very generous comments and recognizes the gentleman from Arkansas, Mr. Thornton.

Mr. THORNTON. Thank you, Mr. Chairman.

I would like to join my colleague from Florida, Mr. Bacchus, in expressing my appreciation to you for the excellent job that you have provided in leading our committee.

I also would like to join in his comments about our priorities. It troubles me, even though this is apparently a significant increase for research, that we are not paying enough attention to the need for making major structural changes in the American economic base; that the driving power of creativity in science must be harnessed to the implementation of those ideas through means of technology transfer and appropriate technology policy if our Nation is to continue to be strong.

I will be supportive of any efforts to extend further benefits to science education fellowships. This is a great driving force for the future of our economic well-being. Like my colleague from Florida, I hate seeing us draining our resources into mistakes of the past rather than applying our resources as an investment in the future, which science truly is.

Thank you, Mr. Chairman.

Mr. BOUCHER. The Chair thanks the gentleman and recognizes the gentleman from Indiana, Mr. Roemer.

Mr. ROEMER. Thank you, Mr. Chairman.

I, too, would like to join my very articulate colleagues here from Florida and Arkansas in commending you for your leadership, not just today but all last year, on a host of these topics concerning not just competitiveness, not just standard of living for people, not just research and development, but all of that translates into jobs, into how we are going to compete with the Japanese and the Germans, into how our children are going to do in the future. Those are pretty easy things to understand in our country.

I come from a district that has been very, very hard hit in the Midwest, in the northern part of Indiana, on losing our manufacturing competitiveness. We have gone from 33 percent of our jobs in manufacturing down to about 16 or 17 percent. The Japanese and the Germans are up at 28 and 33 percent, and we cannot afford that and have a strong, vibrant middle class in this country.

This is what this hearing is all about. We use very different terms. We talk about productivity in our economy. We talk about standard of living. We talk about research and development. All of those things directly translate into fundamental change and new direction in this country so that we can come up with the technology to create the next high- definition television or fiberoptic cable or ceramic engine or aeronautic flight to compete with the Japanese and the Germans.

So I commend my colleagues for their interest today. I commend the chairman, and I look forward very much to the testimony from our esteemed witnesses. I, like my colleague from Florida, do have another Science, Space, and Technology Committee hearing this morning, so I will be going back and forth.

But again, thank you, and thank you, Mr. Chairman.

Mr. BOUCHER. The Chair thanks each of the gentlemen for their comments, all four of whom have made outstanding contributions to the work of this subcommittee during the course of the past year.

Without objection, we will place in the record at this point a statement by the gentleman from Illinois, Mr. Costello.

[The prepared statement of Mr. Costello follows:]

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STATEMENT OF U.S. REPRESENTATIVE JERRY F. COSTELLO (D-IL)

SCIENCE, SPACE, AND TECHNOLOGY SUBCOMMITTEE ON SCIENCE

"NATIONAL SCIENCE FOUNDATION OVERSIGHT"

FEBRUARY 25, 1992

MR. CHAIRMAN, THANK YOU FOR CALLING THIS HEARING ON OVERSIGHT OF THE NATIONAL SCIENCE FOUNDATION. I AM PLEASED TO BE HERE TODAY AS WE DISCUSS NSF. I WOULD LIKE TO TAKE THIS OPPORTUNITY TO WELCOME OUR PANEL OF WITNESSES. I LOOK FORWARD TO HEARING THEIR TESTIMONY.

MR. CHAIRMAN, THE U.S. HAS CHALLENGED ITSELF TO BECOME FIRST IN THE WORLD IN SCIENCE AND MATH EDUCATION BY THE YEAR 2000. THIS IS A BOLD CHALLENGE, BUT CERTAINLY NOT UNOBTAINABLE. I AM CONCERNED, HOWEVER, ABOUT BUDGET LIMITATIONS. WE, AS A NATION, HAVE A LONG ROAD AHEAD OF US TO MOVE FROM THE BOTTOM IN SCIENCE AND MATHEMATICS EDUCATION TO THE TOP IN SIX YEARS.

FY 93 BUDGET REQUESTS FOR NSF IS ONLY A 7 PERCENT INCREASE OVER FY 92. I QUESTION WHETHER THIS IS ADEQUATE FUNDING FOR A PROGRAM WHICH, IN THE PAST, HAS BEEN SUCH A POSITIVE FACTOR IN EDUCATION OUR YOUTH IN SCIENCE, MATH, AND ENGINEERING. I HOPE THAT OUR PANEL WILL ADDRESS THE BUDGET ISSUE AND OUTLINE THEIR STRATEGY FOR MAKING THE U.S. FIRST IN MATH AND SCIENCE EDUCATION

BY THE YEAR 2000.

AGAIN, MR. CHAIRMAN, THANK YOU FOR CALLING THIS IMPORTANT HEARING AND THANK YOU FOR YOUR CONTINUED LEADERSHIP OF THIS SUBCOMMITTEE.

Mr. BOUCHER. We are now pleased to welcome our first panel of witnesses: Dr. F. Sherwood Rowland, the president of the American Association for the Advancement of Science and professor of chemistry at the University of California at Irvine, and Dr. Gordon Nelson, chair of the Council of Scientific Society Presidents and dean of the College of Science and Liberal Arts at the Florida Institute of Technology. He is accompanied by Dr. Bonnie Brunkhorst, who is chair-elect of the Council of Scientific Society Presidents.

We welcome each of you this morning. Without objection, your prepared statements, along with those of the other witnesses who will testify later, will be made a part of the record, and we would welcome your oral summary of those written statements. The Chair would ask that the witnesses please try to keep their oral summaries to five minutes, and then we will have time for questions of each of you.

Dr. Rowland, we would be pleased to begin with you.

STATEMENT OF F. SHERWOOD ROWLAND, PRESIDENT, AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE; AND PROFESSOR OF CHEMISTRY, UNIVERSITY OF CALIFORNIA, IRVINE

Dr. ROWLAND. I think I should speak in this sense both for the AAAS and for the science community in general that we are pleased to have steady increases in the support for the National Science Foundation, because most of us look on the National Science Foundation as the bedrock support for science in the country. It is the place where individual initiative is most effective, especially at the starting point for new developments, when individual proposals not programmed in some other fashion can be brought to the fore, new ideas can be tried, and the enterprise of science pushed forward.

I want to just comment on something which strikes me as being symbolic of the developments over the last generation or so. And I have mentioned in the testimony Dr. Edward Stone, whom I heard two days ago talking about his start. He is now head of the Jet Propulsion Laboratory. He was talking about his elation as a young Ph.D. at being given the opportunity to design an instrument that was going to be put into orbit and that he was given nine months to do this. That it would be possible to design an instrument and put it into orbit in nine months was a characteristic of the 1960s—small instrument, small orbit, small satellite.

Contrast that with the experience of Dr. Joe Waters, whose data you saw in the last two weeks, the remarkable measurements of chlorine monoxide in our stratosphere. But that instrument was a development of an elaboration on an aircraft-borne instrument which he had developed in the 1970s, and that took him about 13 years for an experienced scientist to get that into orbit.

Somehow that is a characteristic of the trend toward big science and big projects, where the ability to try something out becomes so expensive and so involved in all of the procedures of deciding how to do it that the science gets lost for a decade while one waits for the opportunity to do something.

Now, within that range, a generation ago, the Department of Energy and NASA and many of the other agencies were more open than they are now. They are much more programmatically driven now, so that it becomes more difficult for the individual scientist to start out with something new.

That makes it even more important, the role that NSF plays. And so the central fact for NSF, certainly for most of us, is that it should continue to support as strongly as it can individual investigator-proposed science, the place where the new ideas must be coming out so that we will have something to work on in programs 15, 20, and 25 years from now.

You have asked for comments about the FCCSET procedure, and I will speak there only from my experience of it in the global change area. I do not think that the scientific community at the working level is terribly impressed by the Global Change Initiative under FCCSET. It struck us first as being repackaging rather than asking what is the science that can be done and how should we do it.

Rather, it was put together by saying who is doing what and how can we label it as global change. It is certainly expanding somewhat, but it is not felt within the science community that I am aware of that this is a process in which they have much input; that it is coming from top down. This is what we are going to do, and find out what your position is, where you can fit into that, rather than asking what are the scientific problems and how can we best attack them. So in that sense, we are not terribly impressed with FCCSET as a basis for getting science attacked, and as I say, that is just from the one proposal on global change.

Speaking for the AAAS, we very much appreciate the fact that the NSF is now going to treat social science separately. We do think that this is an area that does need to be considered on its own and not be subject to being a minor part of some other directorate. So having a Social Science Directorate is a very good idea.

Then we come to the question of research facilities. As far as research facilities are concerned, the overwhelming aspect of the last 10 or 15 years is the pace at which instrument development dominates what one can do in science and the need for constant renewal of the instrumentation that is available at the various establishments, especially at the universities.

It is disconcerting to be training new students on obsolete equipment, and we want very much to emphasize that we need to keep putting a substantial amount of money into bringing our facilities up to the 1990s level, to have new instruments and to have that spread broadly across the country, simply because the pace of what one can do is very much dependent on the accessibility of such instrumentation.

That is a very brief summary, and I think I will leave it at that point. Thank you very much, Mr. Chairman.

[The prepared statement of Dr. Rowland follows:]

Statement by

F. SHERWOOD ROWLAND

President

American Association for the Advancement of Science

Before the

Subcommittee on Science

Committee on Science, Space, and Technology

U.S. House of Representatives

February 25, 1992

INTRODUCTION

Good morning Mr. Chairman and Members of the Subcommittee. Thank you for inviting me to testify at this oversight hearing on the budget request and the program priorities of the National Science Foundation (NSF) for FY 1993.

I am F. Sherwood Rowland, Professor of Chemistry at the University of California, Irvine. I appear before you today in my capacity as President of the American Association for the Advancement of Sciences (AAAS).

The AAAS is a membership organization of 133,000 scientists and engineers, and has 295 affiliates representing more than five million members in various scientific, engineering and other professional societies. AAAS publishes the journal, Science, as well as policy reports addressing a variety of issues facing science and its related professions.

My own customary and continuing role in science has been as a practitioner of academic research, first in the field of the chemistry of radioactive materials, and for the past two decades as an atmospheric chemist concerned especially with stratospheric ozone depletion and other forms of atmospheric change. From this perspective of the working-level scientist, I have necessarily observed how science has functioned in the United States over the past 40 years.

I choose first to emphasize my concern about the problems of small science, especially for young newcomers to the various scientific fields, in an era of massive appropriations to fund the megaprojects of big science. The National Science Foundation has long played a major role in its support of science as proposed by individual investigators and must continue to do so for the long-term health of our overall scientific enterprise. Studies last year by the AAAS and subsequently by other scientific groups have shown widespread concern about their future careers among the younger scientists, even those apparently well-supported at major institutions.

I shall illustrate my perception of one aspect of this problem by considering two anecdotes about investigations of the atmosphere and space around us. Just two days ago, I heard Dr. Edward Stone, now head of NASA's Jet Propulsion Laboratory, describe his elation a generation ago at being allowed as a new Ph.D. physicist to design by himself an instrument for a small satellite launch, with nine months to complete the work. In contrast, the striking observations of ozone-depleting chlorine monoxide from the UARS spacecraft were made with an instrument very skillfully adapted by Dr. Joe Waters of JPL from his own airborne instrument -- but the time lag now for a highly-skilled, experienced scientist between concept and orbit was about 13 years.

If Dr. Stone's instrument had failed a generation ago, the scientific cost would be regrettable but the financial cost of his small satellite launch would not have been a cause for a congressional investigation. And his next instrument would have been greatly improved as a consequence; fortunately, it worked and he was off into a stellar career. Young scientists need a chance to experiment, and the very nature of the process means that sometimes the result is failure, and this possibility needs to be built into the funding process so that new investigators can join the group of experienced scientists.

Provision for the new idea and the new scientist is heavily an NSF task, and funds for the individual investigator must be high, continuing priority because this is the source of our next generation of scientific leaders. In my own case, the young scientist support came chiefly from the U.S. Atomic Energy Commission, now superseded by the Department of Energy. However, in the current situation in which the mission agencies such as NASA, DOE, and NIH are increasing orienting their support toward carefully-defined programs, the role of NSF in supporting the free-floating, wide-ranging concerns of individual investigators becomes even more critical.

These worries are also strongly affected by the rapidly increasing costs of instruments needed for scientific research and by the obsolescence that new developments in instrumentation place on the existing academic research facilities, as discussed earlier.

THE FY 1993 NSF BUDGET

For over 16 years, the AAAS has monitored and analyzed the federal research and development budget across agencies and institutions. Annually, we sponsor a colloquium on science and technology policy and publish reports on R&D in the President's budget and Congressional appropriations. Thus we bring to today's hearing an understanding of the historical factors influencing the role of scientific research in addressing national goals for improving the physical, economic, and social well-being of all citizens.

Two events of particular significance influence the status of research funding at NSF and elsewhere for FY 1993: (1) the firm caps placed on domestic, defense, and international spending under the Budget Enforcement Act (BEA) of 1990 in order to bring the federal deficit under control; and (2) the dissolution of the Soviet empire and disappearance of its military threat, resulting in renewed anticipation of a potential "peace dividend."

Obviously, these events are related. The BEA caps were established in part to protect the long-standing policy priority of defense spending during the Cold War. They preclude the possibility of translating savings from reduced defense spending into increases on the domestic side of the budget. Nevertheless, now that the Cold War has been declared over, expectations are rising about freeing more money for programs on the hard-pressed domestic side.

However, unless the three caps in the BEA are reconsidered (an action which is currently being discussed in Congress), the FY 1993 budget must work within the framework of the budget agreement, regardless of the pressures for changing national priorities. Consequently, spending for non-defense R&D -- as all other domestic areas -- may be limited to a greater extent than the overall budget climate would otherwise require.

Under the President's proposed budget for FY 1993, $76.6 billion would be allocated to R&D programs, an increase of about $2 billion or 3 percent above FY 1992. OMB's initial figures suggest that defense R&D would grow by 1 percent, while civilian R&D would increase by 7 percent, continuing a recent trend toward shifting the balance between these two components back towards where it was before the defense build-up of the 1980s. However, the split between defense and civilian R&D programs in the FY 1993 budget is still 59 percent versus 41 percent, only about a one percentage point change from FY 1992 levels. While this is an improvement over the 70 - 30 split of the mid-1980s, it is still far from the 50 - 50 division that held through much of the previous decade.

Basic research is again treated well relative to many other areas of federal spending, as has been the case in the past several years. Overall, federal spending for basic research (much of which is conducted at colleges and universities) is slated to rise 8.1 percent under the President's proposals. Taking into account the effects of inflation, this translates into a 4.6 percent increase in real spending power.

For the past several years, the Administration has been moving toward a doubling of the NSF budget from its FY 1988 level. The President's FY 1993 request of $3.03 billion, a $454 million, or 17.6 percent increase above the FY 1992 level, brings NSF closer to that goal. Under this plan, many programs would receive significant increases ranging from 10 percent to over 30 percent.

It should be noted, however, that while the budget is certainly generous to NSF, there is a little less to the increase than meets the eye. A substantial share of the proposed increase ($75 million) is for a bookkeeping change in NSF's Antarctic Program, which has little impact on the Foundation's level of effort. In FY 1992, $100 million of Antarctic Program funds was included in the budgets of agencies other than NSF. Excluding this accounting change reduces the 17.6 percent proposed increase in NSF's budget to 13.6 percent.

Recognizing the essential link between scientific research and economic competitiveness on a global scale, the Administration's NSF budget focuses on two goals: strengthening the research base; and educating and training future cohorts of scientists and engineers. Consequently, two of the most significant items in the budget are the high priority areas of research identified through the FCCSET (Federal Coordinating Council for Science and Technology) process, and the reorganization of the Directorate for Education and Human Resources (EHR). It is to these that I will turn first.

FCCSET PRIORITY AREAS OF RESEARCH

The President's FY 1993 request for NSF places the highest priority on research in four areas identified by the Federal Coordinating Committee on Science, Engineering, and Technology. These areas, and their proposed budgets are: Advanced Materials and Processing Program ($318.5 million); Biotechnology ($205.6 million); High Performance Computing and Communications ($262.0 million); and U.S. Global Change Research Program ($162.5 million). Taken together, these FCCSET initiatives represent nearly 40 percent of the total NSF research budget for FY 1993. Furthermore, the increases in these program areas constitute 45 percent of the proposed growth in NSF's R&D.

There is no doubt that research in these four areas is vital to advancing scientific discoveries with the most promising applications to technology, industry, and health in the future. Furthermore, the scientific community applauds the coordination and planning inherent in the idea of the FCCSET initiatives, which will encourage cross-disciplinary research and the sharing of instrumentation, equipment, and data. In practice, however, the one with which I am most involved, the U.S. Global Change Research Program, does not appear to be driven as much as I think desirable by consideration first of scientific objectives and then how they can best be met. Part of this problem arises from the too large extent in which the Global Change Program was put together by the bureaucratic joining and relabeling of existing scientific turfs rather than a genuine new start from consideration of potential scientific objectives.

Nevertheless, the AAAS cautions the Foundation against devoting a disproportionate amount of attention and resources to these initiatives at the expense of traditional core program support. To the extent that the budgets for each of the FCCSET initiatives have been determined primarily by counting already-existing programs of research (perhaps with some "repackaging"), the effect on other, non-initiative programs may be less than the numbers alone imply. But to the extent that the proposed increases in NSF funding are being directed disproportionately into the four initiatives, there is potential for significant negative impacts on other programs.

Moreover, it is essential to emphasize that identifying the four FCCSET areas as priorities should not mean that other areas of research (e.g., astronomy, chemistry, or geology) ought to decline in importance or see their funding allocations reduced over future years. In short, it is essential that NSF not allow its involvement with the FCCSET priority programs -- important as these may be -- to erode support for its other core research programs.

EDUCATION AND HUMAN RESOURCES

There is no question that one of the most significant issues facing the United States now and in the near future is the quantity and quality of our technically-trained human resources. Our future rests to a substantial extent on our ability to generate and nurture the next generation of researchers who can push the envelope of scientific discovery and provide us with the tools necessary for competing in the global economy and coping with the environmental, resource, and health problems facing us. It is therefore appropriate for the NSF to target a substantial amount of its attention and resources to nurturing the scientific labor pool.

By now it is broadly recognized throughout government and society that science education and appreciation must begin with children in elementary school and be sustained through their academic careers -- as well as their entire lives. It is also clear that increased attention must be paid to finding ways to make science and engineering more attractive to, and inclusive of, a broader range of people -- including women, racial and ethnic minorities, and the disabled -- than it historically has been. AAAS itself has major initiatives in all of these areas.

The Directorate for Education and Human Resources (EHR) at NSF has embarked on an ambitious set of activities to address these issues and to expand science education at all levels. The reorganization of the Directorate, begun in FY 1992, is intended to focus programs and streamline management and to better link NSF's education mission with other federal education reform efforts.

The FY 1993 budget request for EHR is $479.5 million, a 3.1 percent increase over FY 1992. As in recent years, the largest amount, $186.4 million, is dedicated to elementary and secondary education (although it should be noted that this amount is sufficient only to fund programs at their current levels).

As a result of the reorganization, EHR contains new subactivity areas with configurations of programs that differ from previous years. Of particular significance from the point of view of AAAS is the creation of the Systemic Reform activity, which includes Educational System Reform and EPSCoR (Experimental Program to Stimulate Competitive Research), to reflect a "new paradigm" of systemic approaches to science and mathematics education. The President's request of $76 million for this activity represents more than a 70 percent increase from FY 1992 levels, and is intended to increase the number of states receiving grants through the Statewide Systemic Initiatives (SSI) program and to provide additional advanced development awards through EPSCoR. AAAS supports the EPSCoR program as a relatively inexpensive means of assisting states in developing the infrastructure to become competitive in research on a national basis.

Along with the focus on elementary and secondary education, AAAS encourages NSF to continue activities to promote public understanding of science and technology. Encouraging appreciation for the content and methods of science and for the scientific approach among individuals in all walks of life is no less important than nurturing the next generation of scientists and engineers. We commend the current federal strategy for improving public science literacy, that includes, as its first priority, public and community-linked programs. Informal education is a powerful way to educate students and families in the serious study of science.

Although it may seem like a small matter, in this connection we believe it is important to define clearly the authority and accountability for Informal Science Education within the Directorate. This can be accomplished by identifying it in the title of the elementary and secondary subactivity. In addition, an Informal program element would complement the Foundation's student, curriculum, and teacher activities and provide a full spectrum of educational initiatives. Outside-of-school activities involving members of the scientific community, media, museums, community groups, and others create a rich environment for science learning and should be actively encouraged.

ACADEMIC RESEARCH FACILITIES AND INSTRUMENTATION

The ability to conduct advanced scientific research and to entice young people into scientific research careers depends in great part on the environment and instrumentation at hand. The Academic Research Facilities and Instrumentation program at NSF exists to address the need to modernize and renovate aging research facilities and to enable research centers to buy the most advanced instruments in their field.

But, just as it did in FY 1992, the Administration in FY 1993 has proposed only modest funding for instrumentation ($33 million) and no funding at all for facilities. The rationale behind this approach is that instrumentation is more closely linked with economic competitiveness and therefore must be a higher priority.

This claim fails to take account of the growing need to modernize and renovate deteriorating research facilities on our nation's campuses. Last year, NSF reportedly received $450 million in grant applications for the $33 million appropriated by Congress for facilities modernization. It seems apparent that this program could effectively use considerably more money, up to its authorized level of $250 million. It is important that Congress look carefully at this program and consider providing the necessary funds.

I have attempted to address four areas of particular interest today: the support of research proposed individual scientists, the FCCSET initiatives, the reorganization of EHR, and academic facilities and instrumentation funding in NSF.

There is just one additional item I would like to note before closing.

On behalf of the AAAS, I would like to commend Dr. Massey for implementing the recommendation of the Task Force on "Looking To the Twenty-first Century" to establish within NSF separate directorates for the Biological Sciences and the Social, Behavioral, and Economic Sciences. These two units had previously been components of a single Biological and Behavioral Sciences directorate. The change acknowledges the separate, but equally significant contributions of the biological and social sciences, and affords each a better opportunity to advance the research agendas of its disciplines.

CONCLUSION

At a time when our nation's resources seem particularly scarce, and long-standing policy priorities are being reexamined, we in the scientific community should be pleased that the federal government's commitment to research remains strong. The steady growth in the budget of NSF over the past few years signifies the government's recognition of the vital role scientific research plays in enhancing the well-being of all people.

Nevertheless, as has been the subject of increasing discussion and debate among scientists and policymakers during the past year, many academic researchers are encountering severe difficulties in obtaining support and maintaining their laboratories and programs. AAAS is aware that both NSF and the

Science, Space, Technology Committee have task forces looking into the morale problems of academic science. We applaud these initiatives and hope that they will yield concrete proposals for relieving the distress our colleagues are experiencing.

Finally, it is important to note that the structure and the context in which research takes place are fluid, and institutions like NSF must be able to adapt to changing geopolitical and domestic priorities. Strategic planning and reorganization, while not always easy, are part of this process. We are encouraged to see such efforts being undertaken.

I appreciate the opportunity to comment on the National Science Foundation's proposed budget for FY 1993. I would be pleased to answer any questions you may have. Thank you.

DR. F. SHERWOOD ROWLAND

Biographical Sketch

Dr. F. Sherwood Rowland, now Donald Bren Professor of Chemistry, came to the University of California, Irvine in 1964 as the first chair of the Department of Chemistry. He previously held faculty positions at Princeton University and the University of Kansas. He earned his bachelor's degree from Ohio Wesleyan University and his master's and doctoral degrees from the University of Chicago. He is currently the elected President of the American Association for the Advancement of Science.

Dr. Rowland is a specialist in atmospheric chemistry and radiochemistry, and was, with colleague, Mario Molina, the first scientist to warn that chlorofluorocarbons released into the atmosphere were depleting the earth's critical ozone layer. Research on CFC's and stratospheric ozone eventually led in the 1970s to legislation in the United States, Canada, and Scandinavia regulating the manufacture and use of chlorofluorocarbons, and in 1987 to the Montreal Protocol of the United Nations Environment Program, the first international agreement for controlling and ameliorating environmental damage to the global atmosphere. The terms of the Montreal Protocol were strengthened in June 1990 to attain a complete phaseout of further CFC production by the year 2000.

Rowland has also been investigating the impact of methane gas on the atmosphere. Theses studies have shown that the atmospheric concentrations have been increasing steadily at about 1% per year since 1978 and have more than doubled in the past two centuries. The excess release of methane is contributing to the "greenhouse effect," the gradual warming of the earth's surface.

Rowland is a member of the National Academy of Sciences and the American Academy of Arts and Sciences. In 1983, he and Molina received both the Tyler World Prize in Ecology and Energy and the Award for Creative Advances in Environmental Science and Technology of the American Chemical Society. In 1987, Rowland received the Charles A. Dana Award for Pioneering Achievements in Health, and in 1988, he was made a member of the Global 500, the Honour Role of the United Nations Environment Program. In 1989, he received the Japan Prize in Environmental Science and Technology. Rowland has been awarded honorary degrees from six institutions, including the University of Chicago, Duke University, Princeton University, and Simon Fraser University (Canada).

Mr. BOUCHER. Thank you very much, Dr. Rowland.

Dr. Nelson, we will be pleased to hear from you, sir.

STATEMENT OF GORDON L. NELSON, CHAIR, COUNCIL OF SCIENTIFIC SOCIETY PRESIDENTS; AND DEAN, COLLEGE OF SCIENCE AND LIBERAL ARTS, FLORIDA INSTITUTE OF TECHNOLOGY; ACCOMPANIED BY: BONNIE BRUNKHORST, CHAIR-ELECT, COUNCIL OF SCIENTIFIC SOCIETY PRESIDENTS

Dr. NELSON. Mr. Chairman and Members of the subcommittee, thank you for inviting the Council of Scientific Society Presidents to testify before your subcommittee. I am the 1992 chair of the Council, and I am accompanied by Dr. Bonnie Brunkhorst, who is our chair-elect.

The CSSP membership includes the presidents of 58 scientific societies. Societies that send their presidents to CSSP have an aggregate membership of 1.4 million American scientists.

In order to help us prepare today's testimony, we have faxed to all our member presidents a series of questions addressed to the policy issues posed by the subcommittee. In the time available, about a third have been able to provide us their views. The responses we got, supplemented by personal contacts and Executive Board discussions, have been incorporated into this testimony.

You posed two specific questions. In the first of these, you asked what are the advantages and disadvantages of organizing and presenting well over 40 percent of NSF's research programs as part of the cross-cutting Presidential research initiatives.

First let me say our members generally consider the advantages of the initiatives to be large and substantial. Many are of the view that the introduction of the initiatives has, at a time of severe budget constraints, played a significant role in facilitating the broad increase in research funding for all participating agencies and in the 17 percent increase in funding for NSF. We believe the cross- cut Presidential initiatives will serve science and the Nation well.

There are, however, important issues. The priority of the scientific community is clear: disciplinary-based, single-investigator research is that priority. The long-term health of that disciplinary research base is the key to long- term competitiveness.

As DOD is downsized, there is particular concern that the American research base not be undermined. A president of a large society warned that if the cross-cutting served to detract from the core scientific enterprise rather than focusing its efforts to specific needs, it can do a disservice to the scientific enterprise and its ability to explore new, potentially important ideas.

Coordination and priority setting are good for all parties involved in the scientific process. However, there is clear potential for too much of a good thing. Indeed, many of our responding presidents observed that devoting as much as 42 percent of the Foundation's research budget to the cross-cut initiatives would appear to be too much.

Now, some have asked if the cross-cut initiatives amount to little more than repackaging and relabeling of a group of already existing programs. Our members generally reject that view of cross-cuts. One stated emphatically, "This is not just relabeling and repackaging. New ideas and issues are emerging."

Does the cross-cut approach have the effect that scientists will feel pressure to shave or bend their proposals for research support to meet the implied objectives of the initiative? In many fields, scientists have always been funded from categorical programs tied to specific objectives. Scientists have generally felt, however, free to propose the kinds of projects they wish to carry out.

The orientation towards the wider program objectives comes not in the description of the proposed research but, rather, in the justification section of the proposal, and admittedly, there unusual contortions do exist.

As to the extent of participation by the scientific community, one of our presidents, after noting the value of the cross-cut approach in obtaining priorities for science, observed, "The voice of the scientific community in the FCCSET process is a more troubling issue."

To date, interagency coordination has been practically closed to all but Federal employees. While advisory committees and other mechanisms still give access to individual agency priorities, some direct tie to FCCSET decisionmaking could improve the process.

Let me be quite clear. My colleagues in the scientific community are pleased with the way in which Dr. Bromley has revitalized the Federal Coordinating Council. It is operating, we believe, very much in keeping with the intent of the legislation that originated in this subcommittee in the mid-1970s. We urge, however, that the various FCCSET committees and task forces which develop and monitor those initiatives find ways to strengthen the participation of the wider scientific community.

The second science policy issue which you asked us to comment on is the research facilities issue. The decision to undertake a vigorous new facilities program for the national research facilities is, in general, one which we welcome. The new facilities such as LIGO constitute valuable additions to our inventory of national facilities.

Each has no doubt been discussed by the relevant disciplinary advisory committees on their individual merit. It is not clear, however, whether all of these new facilities and their impact as a whole on the overall NSF research program has been weighed to the degree desirable.

Indeed, there is the impression in the community that facilities for small, well-connected groups achieve funding, while the needs of broader, less focused constituencies go unmet.

Let me comment specifically on the separate issue of research facility modernization. Here again, we applaud the decision to undertake a strong effort at the national facilities. But in the area of modernization of research infrastructure at academic institutions, our applause is more restrained.

NSF is again asking for $33 million for one important part of the physical research infrastructure—instrumentation—but no resources to continue the very modest $16.5 million Academic Facilities Modernization Program wisely put in place by Congress in the current fiscal year are being requested. Even this would be only a fraction of the $43 million authorization.

What is missing at the NSF is a capital budget. In contrast to private sector firms engaged in R&D, NSF's budget consists of an operating budget. Even the national facilities, to which the Federal Government retains title, are treated and budgeted for as part of a single budget for current operating expenses.

In conclusion, Mr. Chairman and Members of the subcommittee, summing up our analysis, we find that, one, the cross-cutting Presidential research initiatives constitute a useful approach that promises to strengthen NSF's research programs. However, these initiatives should occupy a somewhat smaller fraction of NSF's total research budget than is the case in the budget proposals.

Second, the program of support for research facilities is an important but currently badly unbalanced part of NSF's effort in support of the physical infrastructure. The strong support for new facilities and upgrading of existing facilities at the national research facilities should be supplemented by an equally strong program of support for new facilities and upgrading of existing facilities at the Nation's universities in order to maintain the vigor and leadership of American academic science.

Third, in policymaking for both the cross-cutting research initiatives and for research facilities, a stronger participation by members of the scientific community is clearly desirable.

Thank you, Mr. Chairman. We would certainly be pleased to respond to questions.

[The prepared statement of Dr. Nelson follows:]

U.S. HOUSE OF REPRESENTATIVES
Committee on Science, Space and Technology
Subcommittee on Science

Statement by

GORDON L. NELSON, CHAIR
COUNCIL OF SCIENTIFIC SOCIETY PRESIDENTS

accompanied by

BONNIE BRUNKHORST, CHAIR-ELECT
COUNCIL OF SCIENTIFIC SOCIETY PRESIDENTS

February 25, 1992

Mr. Chairman and members of the Subcommittee. Thank you for inviting the Council of Scientific Society Presidents (CSSP) to testify before your subcommittee on two important subjects which are significant for the future of American science. I am the 1992 Chair of the Council, and I am accompanied by Dr. Bonnie Brunkhorst who is our Chair-elect.

The CSSP membership includes the presidents of 58 scientific societies in the United States (see list, Appendix I). In addition to the current presidents of these societies, our membership includes the presidents-elect and the past presidents for two years after they have concluded their term as president. This provides continuity in the Council's work. Societies that send their presidents to the CSSP have an aggregate membership of 1.4 million American scientists. To expedite their work, when the society presidents meet and adopt positions on scientific and science policy issues, and when they testify before a Committee of the Congress, they speak for themselves as individuals.

In order to help us prepare today's testimony, we have faxed to all our member presidents a series of questions addressed to the policy issues posed by the Subcommittee. In the limited time available, about a third have been able to provide us their views. The responses we did get, supplemented by personal contacts and Executive Board discussions, have been incorporated into this testimony.

In your letter inviting us to testify, you pose two specific questions concerning the budget proposals for the National Science Foundation (NSF). In the first of these you ask: What are the advantages and disadvantages of organizing and presenting well over 40 percent of NSF's research program as part of the cross-cutting Presidential Research Initiatives.

First, let me say that those of our members with experience and with opinions on this question, generally consider the advantages of the Initiatives to be large and substantial. Many are of the view that the introduction of the initiatives have, at a time of severe budget constraints, played a significant role in facilitating the broad increase in research funding for all the participating agencies, in general, and in the 17 percent increase in funding for NSF research in particular.

Those with experience with other research initiatives of a cross-cutting nature in past years also point to a longer term effect. Such initiatives have always had a finite life. When a special initiative reaches the point of termination, the effect typically has been that the existing initiative budget has been transferred to the relevant base program. For example, when the International Decade of Ocean Exploration program ended, a program for which NSF had lead agency responsibility, NSF's core Oceanography program grew by an approximately equal amount, thus permitting scientists who had worked on the initiative to continue to do productive research in their field.

Thus, on balance, we believe that the cross-cut Presidential Research Initiatives will serve science and the nation well. They promise continued vigor and broad participation by scientists in the fields that come under each of the chosen umbrellas; and they promise substantial technological pay-off that will strengthen the nation's competitiveness.

There are, however, important issues. One disadvantage of this grouping together of research programs is that it has the effect of characterizing a large part of NSF's research as essentially targeted research. The present research initiatives, such as Biotechnology, Materials, and High Performance Computing have titles that suggest that they are predominantly of an applied nature.

In reality, this is not true. NSF will continue to rely on unsolicited, investigator-initiated research proposals. In selecting which proposals are to be funded, NSF will continue to rely on reviews conducted by scientific peers for whom scientific merit will continue to be the overriding factor.

But for those not in the scientific community who are not familiar with how NSF conducts its project selection, the cross-cut initiatives may not be well understood, and the impression that the agency's research is split very roughly, half-and-half between applied and basic research may be created.

The priority of the scientific community is clear - disciplinary-based, single investigator research is that priority. The long-term health of that disciplinary research base is the key to long-term competitiveness. As DOD is downsized, there is particular concern that the American research base not be undermined. A president of a large society warned that "if the cross-cutting serves to detract from the core scientific enterprise, rather than focusing its efforts to specific needs, they can do a disservice to the scientific enterprise and its ability to explore new, potentially important ideas. Coordination and priority-setting are good for all parties involved in the scientific process; however, there is a clear potential for too much of a good thing in this case."

Therefore, many of our responding presidents observed that, apart from the perception of the balance between basic and applied research, devoting as much as 42 percent of the Foundation's research budget to the cross-cut Initiatives would appear to be much too much. One society president stated:" Earmarking such a large fraction of the research budget cannot help but cause other efforts to be shortchanged." Another president suggested that the current level is "inordinately excessive" and recommended a level for these initiatives, especially in the early stages, in the 15-20 percent range.

Some have asked if the cross-cut Initiatives amount to little more than a repackaging and relabeling of a group of already existing programs and activities. Some of our members felt that they did not know enough about the Initiatives to answer that question. But those who did generally rejected that view of the cross-cuts. One stated emphatically: "This is not just relabeling/repackaging. New ideas and issues are emerging from the Global Change and High Performance Computing and Communication Initiatives. Earlier work remains basic, and related current activity does benefit from the new funding. The initiatives are certainly welcome." Another stated: "From my perspective, the Presidential Research Initiatives have done more than simply relabel existing research programs, although a certain portion of the initiatives are composed of ongoing, older programs. While FCCSET reports have given us a comprehensive look at the federal research investment for certain topics, they have also primed the federal agencies to set priorities for the purpose of addressing gaps in knowledge."

Another potential disadvantage of the Initiatives can be envisioned at the level of the individual scientist: Will this approach have the effect that scientists will feel a degree of pressure, however subtle, to shape or bend their proposals for research support to meet the implied objectives of the Initiatives? In many fields of science, especially those heavily supported by the Federal mission agencies such as NASA, EPA, and USDA scientists have always been funded from categorical programs tied to specific objectives. In those circumstances scientists have, however, generally felt free to propose the kinds of project they wish to carry out. The orientation towards the wider program objectives comes, not in the description of the proposed research, but rather in the "Justification" section of the proposal. Admittedly there, unusual contortions do exist.

In the present case, the cross-cut Initiatives tend to encourage interdisciplinary research proposals and projects. The coordination of the Initiatives by the FCCSET committees has provided a new level of interagency cooperation and goal setting. There is increased opportunity for public awareness and attention paid to research that is directed towards important national needs.

As to the extent of participation by the scientific community in the formulation of the cross-cut initiatives, as one of our members succinctly stated it: "It is particularly distressing that the scientific community has had little opportunity to have a voice in this process."

Another of our presidents, after noting the value of the cross-cut approach in obtaining priorities for science, observed: "The voice of the scientific community in the FCCSET process, however, is a more troubling issue. To date, the interagency coordination has been practically closed to all but Federal employees. While advisory committees and other mechanisms still give access to individual agency priorities, some direct tie to the FCCSET decision making could improve the process." Another scientific society president stated: "I would like to see an increased role for the scientific community in FCCSET's priority setting process. Currently, only Federal agency heads have significant input into this process. FCCSET's underlying assumption is that agency heads confer with the science community in setting priorities through their agency's advisory committees and boards. I believe that a more direct role for the scientific community is needed."

Let me be quite clear, in general I and my colleagues in the scientific community are pleased with the way in which Dr. Bromley has revitalized the Federal Coordinating Council. It is now operating, we believe, very much in keeping with the legislation that originated in this subcommittee in the mid-seventies. We urge, however, that the various FCCSET committees and task forces which develop and monitor those initiatives find ways to strengthen the participation of the wider scientific community.

The second science policy issue which you asked us to comment on is the research facilities issue. Specifically, you asked us to comment on the inclusion in the NSF budget of large sums for new National Research facilities and for facilities modernization and upgrading at existing National Research Facilities, while at the same time there is a notable absence of any comparable support for academic research facilities, either new construction or modernization.

Given the strong commitment to new facilities, and in some cases entirely new National Facilities, it is difficult to understand how, at the same time, NSF and the OMB have elected not to request any funds for either new academic research facilities or for continuation of the very modest academic facility modernization program begun in fiscal year 1992. In order to analyze this issue, and suggest new and helpful policy initiatives in this area, it is useful to draw a sharp distinction between facilities modernization on the one hand, and new facility requirements on the other hand.

The question of new research facilities has, on and off, been the subject of debate ever since the Federal government became a major supporter of scientific research at the beginning of World War II. The wartime Office of Scientific Research and Development headed by Vannevar Bush, supported a wide range of research activities, and, as part of that support, provided research facilities needed to conduct certain research activities. Since then we have seen the ebb and flow of Federal funding for research facilities of all kinds in many of the Federal research agencies most notably the NIH and the NSF.

In the budget for fiscal year 1993, now before the Congress, the decision to undertake a vigorous new facilities program for the National Research Facilities is, in general, one which we welcome. The new facilities, such as LIGO and the 8-meter astronomical telescopes, will permit American science in the fields of gravitational physics and in optical astronomy to remain at the forefront. However, we share the NSF Director's concern about the wisdom of simultaneously starting up these two new, very large, and expensive facilities which both are to be funded in the Mathematics and Physical Sciences (MPS) Directorate of the Foundation.

Beyond the MPS Directorate, several other new facilities each constitute valuable additions to our inventory of National Research Facilities. Each has no doubt been discussed by the relevant disciplinary advisory committees on their individual merit. But it is not clear that a careful evaluation of the impact of each of these on the support of other aspects of each discipline, specifically the impact on the level of support for individual investigators or "small science" was carefully done. More importantly, it is not clear whether all of these new facilities and their impact as a whole on the overall NSF research program have been weighed to the degree desirable. Indeed, there is the impression in the community that facilities for small, well-connected groups achieve funding while the needs of broader, less focused constituencies go unmet.

One president writes: "There is serious discontent over the funding of some of the national facilities. I hope that in the future there will be some criteria established that would allow us to make informed decisions regarding the need for national facilities and our ability to finance them effectively." Another president writes: "concerning support and priority-setting in the facilities area, I am concerned about the need for balance. Both 'national facilities' and 'academic research facilities' at individual institutions fill critical needs in the pursuit of science. Yet support for various types and sizes of facilities is not reviewed in a coordinated fashion. Facilities funded through targeted appropriations, grants, indirect cost reimbursement, or Congressionally-directed mandate, whether they are institution-based or national, usually are not considered as a single group of priority choices within a limited pot of money. Given the constrained nature of the federal budget, however, these support mechanisms increasingly compete with one another."

There is an urgent need for new facilities at the nation's universities. The clearest and most unambiguous indication is the decision, now being implemented, to double the NSF budget. That decision recognizes the rapidly growing opportunities for top quality research and the growth in the number of quality scientists to carry out that research. What we now need is a clear-cut recognition that, to accommodate this growth, we need not only support for the modernization of existing facilities, but also support for new facilities to accommodate the growth in the size of the American research community.

A number of concerns, objections, and explanations have been advanced to account for the lack of a research facilities program at NSF. None of them, individually or together, seem to us to be of sufficient magnitude or validity to justify the continuing neglect of this very real need for a strong and vigorous research facilities program.

Without question, non-Federal sources are available. State universities have traditionally obtained most of their support for new facilities from state governments and private universities have traditionally obtained most of their funds for new facilities from private donors, such as alumni and foundations. While this is true, we must recognize the clear, present limitations of both state governments and private donors.

Another, related, objection to the initiation of a Federal program for new research facilities is the concern that the need is so large that any Federal contribution of almost any magnitude can only make an insignificant contribution. This is the objection which unfortunately has come to be labeled "the bottomless pit" objection in some quarters. I think that we must meet that objection head on. First, the expected growth of the American academic research enterprise is finite and can be estimated. Second, no one is suggesting that the NSF alone or the Federal agencies alone meet this need. Federal leadership, however, can play a significant role in this area.

I note finally the fallacy that new research facilities can be funded through the indirect cost reimbursement channel. As discussed at more length below, that form of payment for facilities is intended to cover the use and depreciation of existing facilities, but does not and cannot be used to meet the need for new research facilities.

Let me comment specifically on the separate issue of research facility modernization. Here again we applaud the decision to undertake a strong effort at the National facilities. The upgrade of the academic oceanography fleet, the installation of a new computer at the National Center for Atmospheric Research at Boulder, Colorado, and the renovation of the two large radio astronomy observatories at Arecibo, Puerto Rico, and at Socorro, New Mexico, are sound steps which will insure the continued viability of these facilities for frontier research work.

But in the area of modernization of the research facilities at academic institutions our applause is more restrained. NSF is again asking for $33 million for one important part of the physical research infrastructure: Instrumentation. But no resources to continue the very modest $16.5 million academic facilities modernization program, wisely put in place by the Congress in the current fiscal year, are being requested. Even this would be only a fraction of the $43 million authorization.

This undoubtedly reflects the Administration's strongly held view, recently reaffirmed by OMB Assistant Director Robert Grady, that such costs should be paid for "through the cost recovery process." This ignores the rapidly escalating cost of technical buildings, the multiple uses, and the effects of matching funds and partnership funds increasingly required for many programs.

In a broader sense what is missing at the NSF is a capital budget. In contrast to most other government agencies and private sector firms engaged in R&D, NSF's budget consists solely of an operating budget. Even the National Facilities, to which the Federal Government retains title, are treated and budgeted for as part of a single budget for current operating expenses.

The time may well have come for both the NSF and the Congress to take a careful look at the value of a capital budget for the Foundation. The large capital costs involved, the special need for long-term planning in this area, and, especially, the need to avoid the bunching together of an overload of facility construction commitments which we are experiencing at this point in time, suggest that a capital budget and the associated discipline it imposes would have a positive effect. The inclusion of new academic research facilities in such a capital budget would also help insure that an appropriate balance between National Facilities and academic facilities be achieved.

In conclusion, Mr. Chairman and members of the Subcommittee, and summing up our analysis of the two policy issues which the Subcommittee asked to review, we find that:

A. The cross-cutting Presidential Research Initiatives constitute a useful approach that promises to strengthen NSF's research programs while at the same time focusing on the contribution of such basic research programs to technological advances needed in the American economy. However, these initiatives should occupy a somewhat smaller fraction of NSF's total research budget than is the case in the budget proposals for fiscal year 1993.

B. The program of support for research facilities are an important but currently badly unbalanced part of NSF's effort in support of the physical infrastructure undergirding the research programs which the agency is sustaining. The strong support for new facilities and upgrading of existing facilities at the National Research Facilities should be supplemented by an equally strong program of support for new facilities and upgrading of existing facilities at the nation's universities in order to maintain the vigor and leadership of academic science.

C. In policy making for both the cross-cutting Research Initiatives and for research facilities, a stronger participation by members of the scientific community is desirable. The contribution of advice from the community, and the resulting consensus, has proved valuable in other areas of American science policy, and will, in our view, be equally useful in these two fields.

Appendix I

1992 CSSP Members

Eric E. Ungar
Acoustical Society of America

Marina Stajic
American Academy of Forensic Sciences

Basil T. Doumas
American Association For Clinical Chemistry

Joseph R. Robinson
American Association of Pharmaceutical Scientists

James H. Stith
American Association of Physics Teachers

Ernest L. Eliel
American Chemical Society

Keith Watenpaugh
American Crystallographic Association

Ralph J. Cicerone
American Geophysical Union

Thomas E. Lovejoy
American Institute of Biological Sciences

E. Gerald Meyer
American Institute of Chemists, Inc.

Karen Sharp
American Mathematical Association of Two-Year Colleges

Michael Artin
American Mathematical Society

Donald R. Johnson
American Meteorological Society

Robert L. Long
American Nuclear Society

Randy P. Juhl
American Pharmaceutical Association

Ernest M. Henley
American Physical Society

Jack G. Wiggins
American Psychological Association

Gordon H. Bower
American Psychological Society

M. J. Coon
American Society for Biochemistry and Molecular Biology

Donald D. Brown
American Society for Cell Biology

Thomas A. Fretz
American Society for Horticultural Science

Henry M. Fales
American Society for Mass Spectrometry

John L. Ingraham
American Society for Microbiology

Donald N. Duvick
American Society of Agronomy

John T. Lehman
American Society of Limnology and Oceanography

Mary Helen Goldsmith
American Society of Plant Physiologists

David B. Wake
American Society of Zoologists

John White
Association for Computing Machinery, Inc.

Ellen Weaver
Association for Women in Science, Inc.

Thomas J. Wilbanks
Association of American Geographers

William Culberson
Botanical Society of America

Jill P. Mesirov
Conference Board of the Mathematical Sciences

Roy D. Gerard
Council for Chemical Research, Inc.

Gary H. Heichel
Crop Science Society of America

H. Ronald Pulliam
Ecological Society of America

Patricia G. Calarco
Electron Microscopy Society of America

Christopher D'Elia
Estuarine Research Federation

Dorothy Eichorn
Federation of Behavioral, Psychological and Cognitive Sciences

Francis X. Masse
Health Physics Society

John H. Litchfield
Institute of Food Technologists

Donald G. Morrison
The Institute of Management Sciences

Deborah Tepper Haimo
Mathematical Association of America

Alton Biggs
National Association of Biology Teachers

Mary M. Lindquist
National Council of Teachers of Mathematics

Wendell G. Mohling
National Science Teachers Association

Arnold L. Gordon
Oceanography Society

Charles J. McCallum, Jr.
Operations Research Society of America

Joseph W. Goodman
Optical Society of America

Edward E. Smith
The Psychonomic Society, Inc.

Rita R. Colwell
Sigma Xi, The Scientific Research Society

Robert E. O'Malley, Jr.
Society for Industrial and Applied Mathematics

Robert D. Schwartz
Society for Industrial Microbiology

D. Warner North
Society for Risk Analysis

Roger D. Meyerhoff
Society of Environmental Toxicology and Chemistry

Wolfhard Almers
Society of General Physiologists

Joe D. Goddard
Society of Rheology

John L. Emmerson
Society of Toxicology

William W. McFee
Soil Science Society of America

Mr. BOUCHER. The Chair would like to thank both witnesses for their very thoughtful comments this morning.

The questions that I have really fall into two categories. First, I am interested in exploring with you in some greater detail the need for funding through the National Science Foundation for research facilities, those not operated directly by the NSF, and also exploring the potential for the cross-cutting process through FCCSET and the interagency initiatives, the four that occupy some 40 percent of the budget of the NSF as proposed for fiscal year 1993—whether or not that process holds some promise for a means of establishing priorities within the Administration for ordering scientific research.

Let me start with research facilities. We were told by witnesses last year, who represented universities, that the total national need for research facilities on their campuses was something on the order of $10 billion. We have a current authorization for the NSF to fund research facilities at the level of $250 million per year. That authorized amount has never been met with appropriations, but we have been providing roughly $20 million per year through the NSF for research facilities up until the present time.

First, just a baseline question, is there any belief on your part that the national need has significantly abated, or is that $10 billion figure essentially still what we are looking at in terms of the scope of the need?

Dr. Nelson, Dr. Rowland?

Dr. NELSON. I think that is still the need, and as one looks at what is happening to budgets of State universities and to private universities, that need is certainly not decreasing.

Mr. BOUCHER. Dr. Rowland, do you agree?

Mr. ROWLAND. I think that yes, the need is there. The need is continuous in the sense that that which was the advanced equipment of 1980 may now be obsolete and/or obsolescent, and the question is do you want to go on using the equipment which was good for 10 or 15 years ago, or do you want to have the best that is available? Everybody would like to have the best, and the question is how quickly can you replace it. And we are not doing very well at the present time.

Mr. BOUCHER. Dr. Brunkhorst?

Dr. BRUNKHORST. I am a professor of geology and a professor of science education at California State University, and I am just finishing up my tenure as the retiring president of the National Science Teachers Association in addition to representing the Council of Scientific Society Presidents.

So in the capacities of functioning in both areas of the sciences and science education, the question of research facilities is particularly poignant because the education of future scientists and the general education of our public in the State colleges and universities is directly tied to the quality of the facilities. The image of the support of the public for science and science education learning is related to the students' understanding of how well supported the education process is in the sciences.

So not only have we not solved the research facilities problem,. but the whole situation is augmented now by the need to focus on how our people are learning to become scientifically literate. So research facilities are particularly important.

Mr. BOUCHER. We have heard from some universities that the limit on their ability to do research is really not related to their ability to attract grants but is related solely to their ability to house the research experiments, and that facilities do place a ceiling on the ability of many universities. And I gather from your head nods that that is common from your experience, as well.

Let me ask you this. Is there a meaningful Federal role in addressing this problem, or should we be relying primarily on the universities through State funding or through the attraction of grants from the private sector to solve these facilities needs?

Dr. Rowland?

Dr. ROWLAND. I think that if you are going to rely on State funding and private grants, then you are going to continue what you presently have, which is a great shortage of new equipment.

Mr. BOUCHER. All right. Dr. Nelson, do you agree?

Dr. NELSON. I would agree, and as one looks at State government budgets at the moment and as one reads in Time magazine even about some of the largest and best known of our private universities, the budget issues are massive.

The Federal Government has a role. It does not mean that the Federal Government ought to do it all. But there needs to be Federal participation, not just in one agency like NSF but in a broad number of agencies to begin to address the problem step by step. Unless we begin, the problem will simply continue.

Mr. BOUCHER. Dr. Brunkhorst?

Dr. BRUNKHORST. The Federal Government has a particularly significant role in that the amount of money that can be leveraged from the Federal Government level is small compared to the amount of money that is put in at the State level, but that small amount of money has a much larger impact because of the signals that are sent from the Federal Government and the guidelines for policy development that do flow from the Federal level.

Mr. BOUCHER. And following up on that answer, let me ask this. There are two basic ways in which the Federal Government today, apart from the NSF's $20 million appropriation, assists in facilities construction. One is through the process of simply making appropriations, and that obviously does not involve any degree of peer review. It simply becomes a political decision. The second way is indirect cost recovery.

The Office of Management and Budget has taken the position that indirect cost recovery for universities is really the better way to have funding applied by the Federal Government to build these facilities, and I would ask you to comment on the three possible ways that the funding can be provided: indirect cost recovery, on the one hand, and if that is not sufficient, tell me why it is not; the pure political process where the appropriations committee simply selects certain facilities and makes appropriations for them; and then the National Science Foundation's peer review process, where a determination is made based on merit.

Which is the better way to channel funds? Which among those ways is more likely to leverage support from States and from the private sector? In which of those three processes would the other funding communities tend to have a greater degree of confidence?

Dr. Rowland, we will begin with you.

Dr. ROWLAND. Well, I think the least confidence clearly comes on the political process without scientific input, just that it appears that the facility is going to be funded in such-and-such a district. That certainly does not generate any large support within the scientific community, although it obviously does within the political community.

The indirect cost recovery—the indirect costs are under such pressure now of trying to drive them down that being able to build into that enough money to build new facilities seems to me to be very impractical at the present time, which leaves direct funding through support to NSF or through other agencies.

Exactly which agency should do it is not so clear, but NSF is obviously a logical candidate. And that way at least everybody comes in and explains what they want to do, and you can sort of judge all of them in competition with one another as to how useful it will be to the scientific enterprise.

Mr. BOUCHER. Let me ask you this very specifically, Dr. Rowland. Between indirect cost recovery and the process of NSF making awards based on peer review, which of those two do you think the private sector would have greatest confidence in in terms of contributing to facilities that are being constructed?

Dr. ROWLAND. I think, in my experience, the private sector has not been a very big contributor, anyway, so that it is not that important. Most of the facility contributions have to be coming from Federal or State government anyhow. And I have to say that I would be even more adamant about that up until this particular year, when two of us received two-thirds of a million dollars from the Keck Foundation, so we have a slightly different point of view of private funding than we had a year ago.

Mr. BOUCHER. Dr. Nelson?

Dr. NELSON. Of the three processes, I think the practicality is that all three will exist and need to exist. In terms of indirect costs, indirect costs are based on use of existing buildings built some time ago at much less cost than facilities are today. So the practicality is that that may help but not in fact fund replacement of existing buildings.

There are no funds through that process for new facilities, additional facilities, so that indirect cost, by and of itself, is a small part of the total package.

NSF, in its small construction programs, has what becomes close to comprehensive review. That is, larger multidisciplinary groups getting together and looking at the full impact of a building. A building just is not a research program, but a building has multiple uses, multiple reasons to exist—economic development in a local area, institutional development, educational as well as research—so that what is needed is, in fact, in both the larger, multiple-agency process and within NSF, what is truly comprehensive review beyond peer review.

Mr. BOUCHER. Dr. Brunkhorst?

Dr. BRUNKHORST. If you look at the NSF peer review process for playing a large part of the solution to the problem, you are establishing a signal that the infrastructure of the scientific community is important, and that is where the quality of our science is maintained. So I would suggest that the strongest of the three would be the NSF peer review process.

Mr. BOUCHER. All right. Well, as you can probably tell by the tenor of this question, I am trying to make the case that that is accurate and appreciate your participation in that effort.

What we are seeing in the budget request for fiscal year 1993 is recommendations for significant upgrades at the research facilities that are directly administered by the NSF, no funding for the upgrades of research facilities on college campuses. Is that an appropriate priority? What do you think about the exclusive allocation of money just for the national facilities and nothing for those at universities?

Dr. Rowland?

Dr. ROWLAND. Well, obviously, if you come from a university, you think that the universities need modernization just as much as—

Mr. BOUCHER. But looking at the public policy.

Dr. ROWLAND. I think if one looked at that and tried to find justification, it would have to be that the modernization of the university facilities was being taken care of somewhere else.

Mr. BOUCHER. Do you think it is?

Dr. ROWLAND. No. So in that sense, it is sort of that one problem is being solved, but another problem has not yet been addressed.

Mr. BOUCHER. Do you agree with the priority that suggests that we solve only the national problem and not the one at universities?

Dr. ROWLAND. No, I do not agree with that priority.

Mr. BOUCHER. Dr. Nelson?

Dr. NELSON. Well, I think the problem at the universities is also a national problem. So it is critical that we continue and build upon the very small steps that have already been taken.

Some of the national facilities in fact benefit only a very small community rather than the broader scientific community as a whole, and that is why, in my testimony, I noted the need for comprehensive review.

Mr. BOUCHER. Dr. Brunkhorst?

Dr. BRUNKHORST. Again, the infrastructure of science for this Nation stems from the activities of the universities. Without the feeder system that comes from the universities, we will not have the scientists to work at the national facilities. You cannot have one without the other. So it is a national problem that has to be addressed, and that problem centers on the research facilities that are up to date and functioning at the universities.

Mr. BOUCHER. All right.

I have some questions that I will ask of this panel momentarily on questions related to the interagency process and the allocation of some 40 percent of the monies in the budget to that and whether that holds the seeds for a potential structure for setting priorities in science research, generally.

But before turning to that, I would like to bring our colleague from New York into this discussion, and I will at this time recognize the gentleman from New York, Mr. Boehlert.

Mr. BOEHLERT. Thank you, Mr. Chairman.

I do not want to miss this opportunity to ask one of my favorite questions, and since we are dealing with the problem of modernization of university research facilities, to which we give a very high priority—and you do, also, in your testimony—it boils down to one of setting priorities, and we are always faced with that very difficult task.

How would you prioritize the following? A, putting money into a University Research Facilities Modernization Program, or B, giving $650 million to yet another installment on our contribution to the Superconducting Super Collider?

My namesake first, Dr. Rowland. I am a Sherwood, too.

Dr. ROWLAND. I see.

I think I have to say that outside the high-energy physics community, I hear very little support or interest in what might come out of the Super Collider, so that the support would certainly be for putting it into research facilities.

Mr. BOEHLERT. Dr. Nelson?

Dr. NELSON. There are a variety of reasons for building the SSC, but the scientific portion of that is perhaps one where you would get considerable consensus within the scientific community that those dollars, given a small number of dollars, could be better spent elsewhere.

Mr. BOEHLERT. Dr. Brunkhorst?

Dr. BRUNKHORST. I would just support what Dr. Nelson has said, that there is a need for the large initiative that SSC represents. However, in times that we are facing now, there is a serious question about the appropriate use of that money if we are playing the zero sum game.

Mr. BOEHLERT. We are all singing from the same hymnal. I don't quarrel with the idea that it is good science; the SSC represents good science. I think it does, and I was an initial supporter of the SSC when it was at $4.4 billion. Now that it has almost tripled that, my enthusiasm has waned considerably, and when I have to establish priorities, I would give this a much lesser priority during these difficult times.

During flush periods, I think we would all be saying something quite different. But I am glad to have you on record, all three of you, with that very important question.

Maybe I am going to preempt the chairman a little bit on this one, but he talks about the research and related activities. More than 40 percent of the total funding is going into four FCCSET initiatives. As I have the breakdown here, it is $225 million for the high-performance computing and communications, $155 million for global change, $311 million for advanced materials, and $193 million for biotechnology.

My question is this: How appropriate is the share of the NSF budget? How appropriate is it to devote 40 percent of the NSF to these four FCCSET initiatives? Could we have the same order respond to that?

Dr. ROWLAND. I think that if one looked now at what is categorized among those four initiatives and then went back three or four years ago and looked to see the antecedents, one would find that a major part—probably 80 to 90 percent of that—was already there. It just had not been coalesced into these initiatives. So it is not as though this 40 percent grew from nothing. They amalgamated a lot of existing material into those four.

The worry, I think, that one has is that this is now dictated from above as to how it is going to be spent. It gets more program-oriented as the mission agencies are, and that, I think, is where the concern comes, as to whether you can still get new ideas pumped into that, or how it ties into somebody's table of organization. That is where I worry about the NSF getting too far in that direction.

Mr. BOEHLERT. How about you, Dr. Nelson?

Dr. NELSON. As I said in my testimony, we think that with 40 percent, that is probably too much. Now, the FCCSET initiatives have been the vehicle for very substantial growth in the science budget, and we should not overlook that.

Mr. BOEHLERT. Applaud it.

Dr. NELSON. But if one gets beyond about 25 percent in those initiatives, then for NSF it is probably too much.

The role of FCCSET in coordination again is something to applaud. We now have agencies working together, talking to each other. That is important.

But the role of NSF—and if one looks at the role of MITI in Japan—is to provide that basic research base upon which technology grows, and that is through single- investigator research.

And so if we in NSF grow, certainly, beyond 40 percent, but even beyond the 25 percent, then probably NSF, over a long period of time, would not be nurturing the whole front of research activities that need to go on to maintain competitiveness.

Mr. BOEHLERT. Dr. Brunkhorst?

Dr. BRUNKHORST. I just want to support what Dr. Nelson has said and add an underline to the FCCSET process. It has been beneficial, as you have indicated.

The coordination of the systems is particularly important. That process has helped us to identify what we are doing and to look for the directions that we want to go among the agencies.

I think it is also important that by going through that process, we are using the expertise from the various disciplines and the various specialties and bringing them to bear on particular problems. That cross-cutting approach is very important.

I do think it is also important to emphasize, though, that the percentage of the cross-cutting initiatives is questionable in terms of the function of NSF, and that is to support the development and continuation of the infrastructure for individual research.

Dr. NELSON. I think the degree to which the FCCSET initiatives are being dictated out of Federal employees to the exclusion of the rest of the research community is a concern as well.

Mr. BOEHLERT. Let me ask all of you, is it fair to say that your perception is that the scientific community is as enthused in general about the FCCSET process as I am? How about responding to that?

Dr. NELSON. I think that, overall, there is a strong positive view of the FCCSET process. The concern is related to the input of the scientific community into that process, and it is important, as that process goes forward, that a strong role of advice from the scientific community be facilitated. And that is not the case today, but it really needs to evolve.

Mr. BOEHLERT. Do you say that it is not or is?

Dr. NELSON. Is not the case.

Mr. BOEHLERT. Is not. Do you see it evolving, or are you really concerned? Are you waving the red flag, or are you just sort of issuing the caution yellow?

Dr. NELSON. That process has in fact begun. Dr. Bromley had a conference with a number of scientific society presidents several weeks ago, so that dialogue has begun.

What we are here today to say is that we need to encourage that process, broaden that process. We have the opportunity to get broader consensus, broader enthusiasm, and we need in fact to do it.

Mr. BOEHLERT. Dr. Brunkhorst?

Dr. BRUNKHORST. I think the FCCSET process has been revitalized in the last couple of years, and Dr. Bromley is to be credited with that activity. I do not sense that there is a large concern from the scientific community at this point because the activity has been put into a forward mode.

I think if we continued without improving the contributions from the scientific community, then there would be some serious concerns. It is just beginning to become a concern.

I do want to emphasize that both the scientific and the science education community have benefited from the upgrading of the process of the FCCSET process, and the input from the various types of expertise that are important needs to be continued and encouraged.

So it is not a criticism. It is an encouragement to evolve in a direction of more input.

Mr. BOEHLERT. When you say revitalized, was FCCSET ever something that worked as you would ideally want it to work? At the risk of sounding like a cheerleader for Dr. Bromley, which I am—I don't apologize for that. I think it is so refreshing to find a science advisor to the President who is legitimate in terms of credentials and performance, whereas in the past we have had cheerleaders for SDI. That was the exclusive mission of one science advisor to the President. I did not think that really took the broad view of the responsibility of the job.

So I like Dr. Bromley a whole lot. It is not a partisan statement; I just think he is exceptional in his performance of his job, and I hope he will be very receptive to suggestions and input from the scientific community and open up the process rather than make it more narrow.

Dr. ROWLAND. At the working level, I think you would need to explain to most scientists what FCCSET is because it has not affected their lives. The further you get out of Washington, the less you know about FCCSET being a new arrangement because it has not gone down to the working level of asking people how should we do this, but rather, it is a reorganization of how the policies are considered in the handling in the Federal Government.

Mr. BOEHLERT. Well, in relative terms, too, it is still in its infancy. I think you would concede that.

I gather, then, if I could sum up my interpretation—I hope it is an accurate interpretation—you are just putting the caution yellow sign up; you are not waving the red flag yet.

Dr. ROWLAND. I think, in principle, it is a good idea. But so far, in practice, within the university community, I think they feel, well, it has not hit us yet; we have not been asked for participation. So the question of how it is going to work out is still in the future.

Mr. BOEHLERT. Dr. Nelson?

Dr. NELSON. We have a process that is beginning to work. It is a new process. It is one really, for the first time, that FCCSET is starting to get the kind of coordination and cooperation between agencies. Priorities are being set.

So we now have the opportunity to create a process of advice which will in fact not only get us to a broader and more useful set of priorities but also begin to capture the energy, the enthusiasm of the entire scientific community.

So I think it is an opportunity, now that we have a process that is beginning to show promise of actually working.

Mr. BOEHLERT. Good.

Dr. Brunkhorst?

Dr. BRUNKHORST. I think the FCCSET process should be praised. There would not be the concern about input if they were not active in the process of the interagency discussion, so it is a positive situation. It is just that we would like to see the opportunity enhanced for input into that process to move it along in a direction that would be more useful.

Mr. BOEHLERT. Right.

Thank you all very much. Thank you, Mr. Chairman.

Mr. BOUCHER. The Chair thanks the gentleman.

Dr. Rowland, in your opening statement, you had indicated that your direct experience with the FCCSET process in the global change initiative led you to believe that, at least in that application, they were to a large extent simply renaming research that was already under way as global change research and then having that fit within the umbrella of that initiative.

Do you generalize that across the spectrum to other FCCSET initiatives, speaking as the chair of the Council of Scientific Society Presidents, or do you restrict that criticism just to the global change initiative that you have had direct experience with.

Dr. ROWLAND. Well, I am not the chair; Dr. Nelson is.

Mr. BOUCHER. Oh, I am sorry. You are the president of the American Association for the Advancement of Science.

Dr. ROWLAND. Yes. But that would have to be restricted to my own experience in global change. I do not know about how it is within the other three areas.

Mr. BOUCHER. Let me ask each of you this question. We are interested in this subcommittee, as I think many are in the Congress, in beginning to address the need for the establishment of priorities generally in the funding of scientific research by the Federal Government. I think there is a consensus now that we can no longer afford to fund all of the good projects, and we have simply got to start setting priorities with respect to what we do fund.

Does the FCCSET process, particularly, as represented in these four initiatives for the National Science Foundation for fiscal year 1993, hold the seeds of a means by which we can begin to set priorities? Do you think that that is a good beginning? Should we rely more on the FCCSET process as we address the need for priority setting, or do you have other recommendations for us as to ways that can better be handled?

Dr. Nelson, we will begin with you.

Dr. NELSON. I think that if a mechanism or set of mechanisms can be developed whereby there would be direct scientific community input into that process, then it certainly is a hopeful process.

One of the concerns, however, is that by fixing on a set of what appear to be to some applied objectives, that one needs to keep in mind that probably for NSF three-quarters of the objective is in fact not in those applied areas but, rather, is in the building of the basic research base of this country. And those are not cross-cut initiatives; those are base building.

Mr. BOUCHER. Dr. Rowland?

Dr. ROWLAND. I might as well say here what I said last summer at a meeting called "Scientist to Scientist", and that is that the setting of priorities that affect science seems to me to be largely dictated by factors other than science itself. So I characterize it that the role of the scientist is sort of like the pilot fish around a great whale. You try to find something to nibble at and avoid getting crushed.

It is a situation where the priorities are being set by jobs in Texas or in California, and science is used in the advertising. But the decisions as to what science one does are not coming out of the scientific community but have gotten to be large enough in terms of dollars and budget that other factors dominate what you actually do.

So the question of manipulating parts of the budget with scientific objectives foremost becomes a relatively minor part of the total budget. However, in the NSF, that is a major part of NSF.

Mr. BOUCHER. I will yield to the gentleman from New York.

Mr. BOEHLERT. Boy, it sounds like we had the same preparation for today's hearing.

One of the things I have argued with respect to the SSC is that it was signed onto by a great many people, particularly in the Congress, as a public works jobs bill rather than a scientific initiative. If it were viewed strictly as a scientific initiative and prioritized, I think it would come down much farther on the list.

Dr. ROWLAND. This past summer, at the same meeting, there was a statement by one of the people involved in the SSC, and I have no quarrel at all. I think that the science involved is—

Mr. BOEHLERT. Good science.

Dr. ROWLAND.—good science, is great science. But as he put it, it is not that much. It is only $350,000 a year for 25 years for 2,500 physicists.

Now, my thought was that if we were going to award $350,000 a year for the next generation to 2,500 scientists, I am not sure I would put them all in high-energy physics. I think I would put some of them in archeology, I would put some of them in chemistry, and so on.

So it is an enormous commitment of money in one very important but narrow area of science, and I think that it is being done at the expense of a lot of other areas where the benefit might be greater. If we are really going to fund 2,500 scientists at that level, I would like to distribute it more widely.

Mr. BOEHLERT. There is the rub. It is being done at the expense of—The testimony that we heard prior to the committee moving ahead with this project almost universally, from the scientific community, was that they would be supportive if it were to be in addition to all the other things that we think are needed.

Thank you, Mr. Chairman.

Mr. BOUCHER. The Chair thanks the gentleman.

Dr. Nelson, did you want to comment?

Dr. NELSON. There have been numerous comments with people saying that scientists ought to set priorities, and if scientists do not set priorities, well, we are going to do it. Scientists are willing to set priorities, and perhaps that is the reason they have not been asked to set those priorities.

Mr. BOUCHER. Well, how do we get the scientists to do that? I, for one, think that that would be probably the best intelligence this Congress could get in terms of what should be funded and what should not. But how do we organize it? Do you have any practical suggestions?

Dr. NELSON. There are numbers of scientific organizations—ours for one—with those in the presidential succession of 58 of the major scientific societies, which certainly stands ready to help in that process.

Scientists are not without opinions, not without willingness to provide that advice, and certainly, as we do in our semiannual meetings, they discuss and take positions on these very issues.

Mr. BOUCHER. Dr. Brunkhorst?

Dr. BRUNKHORST. I want to go back to focus on your question about the FCCSET process as being the potential means for developing national science policy.

I would not speak for the FCCSET process, but I would wonder if even the FCCSET member agencies have the desire to fix national policy. In a sense, they have the process for impacting national policy, but there is a danger that FCCSET could become politicized. And I am not sure that the scientific community would feel comfortable with having FCCSET the sole focus for developing national science policy.

However, FCCSET, as a part of the process of developing national science policy, has been and should continue to be instrumental in influencing it in positive ways, again with the input from the appropriate constituencies.

Mr. BOUCHER. Well, as a practical matter, the FCCSET process is now prioritizing 40 percent of the NSF's budget. I mean, that is a reality we are dealing with. And I guess my question is, is that a good way to have it happen? Should we borrow from that example and have it happen to a greater extent? Let's focus perhaps on the down sides of that happening. To what extent does the use of the FCCSET process to order the expenditure of 40 percent of the NSF's budget restrict flexibility perhaps to respond to unanticipated opportunities that may come along? Or to what extent does it interfere with funding in the core disciplines that have historically been the mission of the National Science Foundation?

Would you care to comment on that? Dr. Nelson?

Dr. NELSON. Our view is, really, that 40 percent is too high, that in NSF it should be about 25 percent; that we have not seen the increases that are really essential for core disciplines at NSF over the last few years.

So the building of the basic research infrastructure in fact needs to be one of the set of priorities that FCCSET looks at, and this is particularly important as one looks at DOD downsizing. Where is the basic research infrastructure that DOD has supported through the years? Is that going to be continued in DOD? Where is it going?

So one of the key priorities that this committee and FCCSET need to look at is where is that research base, because that is where competitiveness is.

Mr. BOUCHER. I gather, then, you are concerned—since you recommend that 40 percent is too much of the NSF budget to be devoted to these four initiatives—that there may be some adverse effect on core disciplines or the ability to respond to new opportunities. Is that a fair statement?

Dr. NELSON. I would agree.

Mr. BOUCHER. Dr. Rowland?

Dr. ROWLAND. Let me look at it through the particular area of atmospheric chemistry. This is an area that did not exist in the National Science Foundation as a place to which individual proposals could go, say, in 1970. It has been there for 10 or 12, 13 years, some number of that sort, that people could start applying directly there.

Within the core discipline of chemistry, atmospheric chemistry would not do very well, did not do very well, and it grew more or less out of the Earth sciences and is believed, I think, now to be a discipline that is worth supporting.

Well, the atmospheric chemistry is included under FCCSET. It is included in the global change part, and it is getting somewhat more money. But it is still not really a very large sum of money, and the proposals that go there are individual proposals and are being refereed in the same way that a proposal would have been if it had gone to chemistry or physics or one of the core disciplines that was there 20 years ago.

So to some extent, what has happened is an expansion of the areas that are considered core. And this happens to be then classified as global change. So I would say it is a little bit misleading to say this is highly programmatic. It is programmatic in the sense that it says you should spend the money on atmospheric chemistry, and then individuals propose to say what they would like to do and go through the same kind of refereeing process that anyone else does.

Mr. BOUCHER. All right.

I am going to conclude with this panel at the moment. I have other questions I would like to ask, and this is, for me at least, a stimulating discussion.

I want to thank all of you for your attendance this morning and for your helpful testimony. With the subcommittee's thanks, this panel is excused.

Dr. NELSON. Thank you.

Dr. ROWLAND. Thank you.

Dr. BRUNKHORST. Thank you.

Mr. BOUCHER. Thanks to all of you.

We will now turn to the second panel this morning: Dr. Mark Wrighton, the provost of Massachusetts Institute of Technology; Dr. John White, the dean of engineering of the Georgia Institute of Technology; and Dr. William Wulf, professor of computer science at the University of Virginia.

Your prepared statements will be made a part of the record, and we would welcome a brief oral summary—kept, hopefully, to five minutes—of your prepared statements, and then we will proceed with questions.

Dr. Wrighton, we will be pleased to begin with you.

STATEMENT OF MARK S. WRIGHTON, PROVOST, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Dr. WRIGHTON. Mr. Chairman, thank you for the opportunity to be here. I am MIT's chief academic officer, but I also hold the subtitles of "chief budget officer" and "space czar". Space czar means I am responsible for space change, renovations, and construction projects related to the scientific and educational enterprise at MIT. So I should be in a pretty good position, after a year and a half now of looking at this, to comment on the role of support for facilities.

Let me first give you a glimpse of the activities of MIT, and then comment in general terms on the NSF budget, and then address your particular concerns.

MIT is a research university. We have about 9,000 students, half of whom are graduate students. We believe very strongly in the tight coupling of research and education, even with our undergraduates. More than 75 percent of our undergraduates are involved in research.

We also believe very strongly in the mission of education relating to this country's future and especially so in connection with the role of women and minorities in the science and engineering disciplines. In the entering class this past year, we have 35 percent women, 16 percent in underrepresented minority groups, and less than 10 percent of our students are foreign citizens.

Chuck Vest and I, Vest being our new president, have undertaken to rededicate our institution to our central mission, namely education. We believe that this is critical for us and for the future of this country, and we have in fact dedicated some of our own private resources to this effort.

Just this past month, I have announced a new program that will be endowed with $10 million of support from the private sector to enhance our educational process. A program called the Mac Vicar Faculty Fellows Program will recognize and enhance outstanding contributions in education.

The role of the private sector is very important to MIT and to the research community. I might note that MIT's involvement with the private sector is substantial. In fact, we designed our Industrial Liaison Program before the existence of the National Science Foundation. At the moment, we receive more support from private industry than we do from the National Science Foundation.

We believe that this coupling between the university, the government, and the private sector is critical, in part because our most important product from the university sector will be people, and these are people who will join the private sector in the main and contribute to the kinds of economic competitiveness that we heard about in the introductory remarks.

Let me comment now on the general situation with respect to the NSF budget. We are appreciative of the proposed 17 percent increase. This is very welcome news. It will relieve some of the tensions created with our single principal investigator grants program. It is my view that not only are there too few single principal investigator grants programs but, in general, they are too small.

The current situation has created what I refer to as a risk-averse environment for undertaking major new research projects. The need to obtain research results creates an atmosphere where individual investigators themselves have become conservative. And it is not just money; it is the research community itself, which takes an adverse response to people who do not achieve in the research arena. And I believe we place too little emphasis on the educational achievements that are accompanying research activities.

I believe the research community needs to encourage more risk taking. I think that this is critical to developing new areas for science and new technological opportunities.

The enhanced resources to the National Science Foundation will, however, relieve some of the financial tension, and I believe that these investments are extraordinarily well placed.

Let me give you an example of what I mean by the importance of the single principal investigator grants program to technological development. A few years ago, there was announced a major discovery in the general area of materials related to high-temperature superconductors. Within six months, literally hundreds of research groups in the United States were mobilized to work in this area and now lead the revolution in science in high-temperature superconductivity. I believe that a well-supported single principal investigator grants program is what makes it possible to rapidly move when new developments take place in science.

In connection with the four special initiatives that we have heard about, it appears that not only are these justified on the basis of critical needs in these areas, but stunning scientific achievements in the last period of time and the practical consequences that we can promise as a consequence of investment in these areas all will justify the substantial new investments made in these initiatives.

You have appropriately raised concerns about the balance of support for the initiatives versus the core programs. I would like to point out that the underlying sciences for several of these—biotechnology, high-performance computing and communications, advanced materials, and global change— the underlying sciences for these in many respects did not exist at the time the National Science Foundation was itself founded. Computers did not exist. The world of molecular biology was unknown.

At the same time, chemistry, mathematics, and physics—their traditional core areas—spawned these new areas of science. It would be inappropriate to back away from our core support for these traditional areas of science, particularly those that are associated with major economic developments and economic strength.

As a chemist myself, I might point out the special role that chemistry plays in the U.S. economy. The chemistry industry employs approximately 1 million people, and it contributes to a positive balance of trade to the extent of $10 billion to $15 billion per year.

The National Science Foundation support of basic research in chemistry is critical to a strong chemistry industry, and I believe that those investments need to be commensurate with the opportunities in chemistry.

The point here is that there has been real growth in science—computers, electronics, molecular biology, communications—areas that simply did not exist. This is what justifies real growth in the basic NSF budget.

I would like to also point out that the continuous investment in education and research in the science and engineering areas can pay off handsomely. In two independent studies of the activities of MIT faculty and students in connection with starting companies, I would like to point out that in the New England area, we are credited by the Bank of Boston with creating 300,000 jobs, and in Northern California, by the Chase Manhattan Corporation, we are credited with creating 150,000 jobs. So investments do pay off.

Let me comment a bit on the organizational structure of the agencies in the Federal sector and in the universities in connection with dealing with the special initiatives that lie before us.

We believe very strongly that there are exciting opportunities for the university researchers and for the country in connection with these major initiatives. And in the past, the National Science Foundation has in fact led organizational innovation through its Materials Research Laboratories, the Engineering Research Centers, and the Science and Technology Centers.

But I question now whether the NSF and the other agencies are properly organized for addressing problems as complex as global change or communications. We at MIT are now developing our own organization for dealing with global change, for example, and this will involve all five of our schools. The Schools of Science and Engineering, of course, will take leads, but Architecture and Planning, our Sloan School of Management, Humanities and Social Science, our Lincoln Laboratory, and our relationships with Woods Hole Oceanographic Institute will all be brought to bear to address this complex set of issues.

It is no longer the case that science- and technology- based problems can only be dealt with by scientists and engineers. This has always been true, of course, but we in the university community are now prepared to deploy our resources to address very large-scale, very complex systems, and we believe that we are going to be dealing with a discipline diversity that simply has not existed in the past.

Turning to the issues surrounding facilities and infrastructure, let me point out that access to state-of-the- art facilities and equipment is critical for the United States, inasmuch as having access to the state-of-the-art facilities is what makes it possible to address the state-of- the-art questions.

If we do not have the equipment, others will be asking those questions first and obviously will be achieving answers. It is important for the scientific community to have access to state-of-the-art equipment, both locally and, as appropriate, in major national facilities.

Regarding infrastructure renewal, I view the situation as the following: With the current support provided to the National Science Foundation, in particular, the budget is simply too modest to accommodate the needs that the university sector would face, and I would like to urge you to consider again the White House Science Council report from 1986 which called for a $500 million per year investment in facilities renewals and consider modernization of the indirect cost guidelines in connection with such activities.

I would like to close by emphasizing the important role for the education component of our research enterprise. Research and education are very tightly coupled. I have now been at MIT for 20 years and have enjoyed National Science Foundation support for most of that period.

I recall one of my first graduate students, Dr. David Morse, who is now a director of materials research at Corning. Since joining Corning about 16 years ago, he is credited with patented discoveries leading to commercial sales totalling more than $1 billion. He worked with me on a project in the area of inorganic photochemistry. It was quite difficult to predict then the extraordinary success that he would realize.

This story, I think, can be duplicated many times among the alumni of the research universities in this country. Through the Graduate Fellowship Program and the undergraduate activities, NSF has done well in supporting these students, and with enhanced resources such as the promising new Graduate Traineeship Program, I think the Foundation can do better.

Thank you very much, and I would be happy to respond to questions.

[The prepared statement of Dr. Wrighton follows:]

Testimony before the House

Subcommittee on Science

Tuesday, February 25, 1992

by

Mark S. Wrighton

Mr. Chairman, I am Mark S. Wrighton and currently serve as Provost of the Massachusetts Institute of Technology. As MIT's Chief Academic Officer I am responsible for all academic and research programs at the Institute. I have served as a member of the Chemistry faculty at MIT for over nineteen years and have been fortunate to receive generous support for my research and educational activities from the National Science Foundation for most of my academic career. Thus, I am grateful for this opportunity to participate in this oversight hearing.

Having been a recipient of single principal investigator NSF grant support and support from the NSF-supported Materials Research Laboratories, as well as having been mentor to both NSF Predoctoral and Post-doctoral Fellows, I am personally familiar with questions you posed to me in your invitation to participate here. Further, I have served the scientific community and the NSF as a former member of the NSF Chemistry Advisory Committee and presently serve as a member of the Materials Research Advisory Committee.

I will provide a response to specific questions shortly, but first I wish to comment briefly on the role of the NSF and lend my support to the proposed budget for FY93. Indeed, considering the opportunities to seize leadership in areas of science and engineering vital to the United States, the proposed 17% budget enhancement could be viewed as a modest, conservative investment in this nation's future. The support to universities from NSF is absolutely essential to achieving the scientific and technological innovation that results in increased productivity in our economy. Such support comprises a large fraction of the support leading to discovery, to the applications of discovery, and to the education of future leaders of science and engineering.

To provide a sense of the current situation let me summarize an encounter I had with Mr. Erich Bloch, former NSF Director, when I served as Chair of NSF's Chemistry Advisory Committee. Mr. Bloch asked "What do we do well?" I responded "NSF supports excellent science." Mr. Bloch then asked "What do we do that is not so good?" To this I answered, "You do not support excellent science!" The point here, Mr. Chairman, is that far more excellent work is proposed than can be reasonably supported by NSF.

The lack of resources to respond favorably to excellent proposals has serious negative consequences which include the following: (1) it is difficult to support new investigators, because such individuals do not yet have a "track record" on which to judge the probability of success in execution of good ideas; (2) those who are declined tend to re-submit their proposal, but a series of rejections degrades their morale and they ultimately become "research drop outs"; (3) students of research drop outs are persuaded against careers in science and engineering research when the funding is too constrained; and (4) perhaps most importantly, the current system with resource constraint creates a risk averse research community. Risk aversion arises, because the need to produce results becomes paramount -- results stem from ideas that "work". But in research risky ideas need to be pursued, even though we know that many risky ideas fail and yield no "results". Without results there is a weak on-the-record set of achievements to justify continued support. Accordingly, the tendency is to be more conservative and pursue less bold, less risky research that works. Unfortunately, the serious negative consequences of constrained funding affect all research institutions supported by NSF, including MIT. In my personal experiences I find excellent people wherever I travel, but unfortunately, the fraction of those supported is simply too low to realize the considerable potential of the research community. Taking on high-risk projects requires more than just money, however. The scientific community itself needs to recognize its own conservatism and reward risk takers. Signs of this are present, in that NSF renewal awards do take into account the educational achievement as well as research results.

The proposed increase in the FY93 NSF budget is a welcome step in relieving the serious financial problems associated with single principal investigator grant programs of the Foundation. Increasing the number of grants relieves some of the strain, and increasing the grant size can provide funding levels more consistent with the opportunities. Evidence that a strong single principal investigator grant program is a real asset to the country can be seen in the amazing response of the research community to the announcement a few years ago of the discovery of the new high temperature superconducting materials. Within just a few months chemists, physicists, materials scientists, ceramists, theorists, and chemical engineers -- scientists AND engineers -- were able to claim a revolution in science. This scientific revolution now comprises the basis for technological advances in power transmission and electronics.

The ability of the U.S. research community to rapidly respond to new discovery is a consequence of the world's leading academic research enterprise rooted in single principal investigator programs. The ability to lead future revolutions in science requires strong, continuous investment in the NSF programs. Further, applying discovery to society's benefit requires yet additional investment and the proposed interagency initiative on Advanced Materials will contribute to realizing the economic promises of advances in science such as new superconductors.

Indeed, four interagency initiatives, Global Change, High Performance Computing and Communications, Advanced Materials and Biotechnology, all stem from critical needs, stunning scientific achievements in recent years, and the promise of enormous, sustained practical consequence associated with improving the nation's economic health and the quality of life. For the NSF, the critical point is that much basic work needs to be done to support the initiatives and educated people are needed to lead the attendant industries. Thus, my answer to your question regarding the initiatives is that advances and opportunities in the four areas are more than ample justification to enhance investment, but you are correct to question the balance of support for initiatives versus traditional core program support. The traditional areas of chemistry, mathematics, and physics, for example, spawned developments that have led to the current set of achievements and opportunities which justify the initiatives. However, the sciences underlying the four new initiatives did not exist when NSF was founded! These new science areas require new support to sustain development, but tradition areas require continuity.

The economic consequences associated with new fields of science are so great that we cannot afford to not invest in them, but at the same time one cannot abandon the basic sciences which fuel innovations in strong industries such as chemistry, which is a major industry -- approximately 1,000,000 workers -- with a $10-15B/year positive contribution to the balance of trade. The bottom line is this: real growth in support to the NSF is in the nation's interest, because new developments in science can lead to major technological advances having large economic impact. For example, in two independent studies of the impact of MIT research and education programs, MIT faculty and alumni have been credited with creating about 350,000 jobs in New England and about 150,000 jobs in Northern California.

The initiatives concerning Global Change and High Performance Computing and Communications are ones which are somewhat different from Advanced Materials and Biotechnology. Each of these initiatives has obvious importance, but the range of discipline of importance to Global Change and Communications is very, very broad. While NSF has been a key supporter of "interdisciplinary research" through programs like the Materials Research Laboratories, the Engineering Research Centers, and Science and Technology Centers, both the research universities and the NSF may have to consider new organizational approaches to addressing the areas of Global Change and Communications. At MIT, for example, we have established a Council on Global Environment which I chair to coordinate the Institute's activities in environmental education and research. The Schools of Science and Engineering are, of course, well-represented on the Council, but addressing the key questions in Global Change (and Communications) requires the involvement of our School of Humanities and Social Science, Sloan School of Management, and School of Architecture and Planning. Economics, planning, policy, political science, and management are critical components of programs in Global Change and yet scholars in these areas are not traditional collaborators of scientists and engineers. At this point, both we in the research universities and those in the Federal agencies, including NSF, need to assess whether we can marshall diverse resources to address the problems of areas which are science and technology-based, but which are also tightly linked to global scale issues involving economics, politics, and the way our industries function. Global Change represents just one one of the "very large scale systems" areas the nation must be prepared to address with people and support -- both deployed in imaginative new ways. A certainty of the future is complexity, and the research universities stand ready to assist in addressing science- and technology-based problem areas where there are unprecedented levels of complexity and discipline diversity. University and research agencies alike ought to review their organizational structure to insure that they are equipped to meet our future challenges.

Other questions you have asked me to address concern national facilities, infrastructural support, and new research facilities in universities. Regarding national facilities, it is clear that advances in science do depend on access to large, expensive facilities which are too costly to be built at every university. These facilities are widely used to support a large number of individual investigators. National facilities allow U.S. scientists to work at the frontiers of their disciplines. The facilities should be supported in proportion to the significance established by the user community. Clearly, the scientific community must assume the responsibility for setting priorities for such expensive facilities. The important point is to support those selected with resources to run them well. An overarching aim should be to provide U. S. scientists the world's best tools, instrumentation, and facilities for their work. Access to the best equipment makes possible investigations that others are not able to pursue. Thus, the access to well-supported, state-of-the-art facilities and equipment will sustain U.S. leadership in scientific research.

You are correct to raise concerns about infrastructure support and renewal of research facilities at universities. Today, the rate of change in science and engineering is great and requires rather frequent laboratory modifications. We often face such problems in recruiting new faculty where our own capital outlay might be typically $300K for the "start-up costs" on experimentalist. This support does not include resources needed to renovate laboratories. The universities are simply not in a position to support all of the changes in facilities required to execute new research in areas like materials science, biotechnology, global change, and high performance computing and communications. New areas of research require new facilities --- renovated labs and in some cases, new buildings. Unfortunately, the present NSF budget is not strong enough to support a significant portion of the needs of the research universities. Further, introducing more programs where the universities must provide matching resources reduces the flexibility of the university in ways which are damaging to the overall education and research effort. My conclusion is that MIT is presently stretched to the limit in terms of providing matching funds. I suspect other universities are in a similar situation. Unfortunately, resources at the level of tens of millions of dollars do not even address the needs of one major research university: neither the current or proposed NSF budget should be viewed as adequate to address facilities and infrastructure problems at research universities. The 1986 report of the White House Science Council recommended that a $500M program be added to the National Science Foundation, and, also, that indirect cost guidelines be modernized. Neither of these sound recommendations has been adopted.

I must conclude, therefore, that under present constraints, NSF's highest priority must be to support the best science and engineering research. The scientific community must be relied upon for judgements regarding what constitutes "the best". Much of the best involve graduate education and post-doctoral education where the immediate benefits are the educated people who leave academia and amplify the NSF investment. I recall one of my first graduate students, Dr. David L. Morse, now Director of Materials Research at Corning, who worked with me as a graduate research assistant on an NSF-supported project on inorganic photochemistry. Now, sixteen years after joining Corning, Morse's patented discoveries in inorganic photochemistry and materials science have led to significant commercial sales --- now totalling about a billion dollars worth! There are many other stories of this kind and we can all take pride in the accomplishments of the people we educate. Our best placed financial investments now would be those that continue to put our human capital to work. Through its graduate fellowship program and its undergraduate activities, NSF has done well in this regard. With enhanced resources such as the promising new graduate traineeship program, the Foundation can do better.

Thank you for the opportunity to participate in this hearing. I would be pleased to respond to your questions.

Mr. BOUCHER. Thank you, Dr. Wrighton.

Dr. White?

STATEMENT OF JOHN A. WHITE, DEAN OF ENGINEERING, GEORGIA INSTITUTE OF TECHNOLOGY

Dr. WHITE. Thank you very much, Mr. Boucher. It is good to see you again. Mr. Packard, Mr. Nagle, it is good be with you again. You and I, I guess, were on the program together at the University of Iowa a year or so ago. At that time I was the Assistant Director for Engineering at NSF. And I was before you last year as Acting Deputy Director at the Foundation. I am now back in the university as Dean of Engineering at Georgia Tech.

It is a pleasure, as well, to be here with Bill Wulf, with whom I served at NSF, and with Mark, whom I got to know because of my position at NSF.

I am going to focus primarily on the FCCSET process. And especially after the testimony from the first panel, I think it is important for me to try to share with you as candidly as I can some of those intricate details of what was going on behind those closed doors so as to try to allay some fears and some suspicions about what is going on in the FCCSET process.

Also, I would want to give you the opportunity to ask me any questions that you would like about my three years at NSF. And I will be just as candid as I can possibly be about that experience, because I frankly count it as the highlight of my professional career. And I would encourage anyone in the university who has a chance to come and serve their country in that way to do so. And I would want to remind others who come before you that a large number of those at the National Science Foundation are in fact practicing scientists and engineers from academia, and they do not forget that when they show up at NSF.

Let me address the FCCSET process from both a FCCSET point of view and an agency point of view. As you may know, I chaired the steering committee for the Advanced Materials and Processing Program. And in that capacity, I had occasion to work closely with OMB and OSTP.

I came away from that experience with a very strong appreciation for the complexity of the coordination process, as well as considerable respect for the dedication of the people involved in trying to make the process work.

Initially, I expected OMB would present the greatest challenge in designing the advanced materials initiative. I anticipated considerable resistance in defining the scope and scale for that initiative. But that was not the case. In fact, I found OMB to be extremely helpful throughout the process.

Instead, the greatest difficulty was in gaining high- level visibility and commitment to the materials initiative early in the budget cycle across all agencies. The subject of advanced materials frankly was just not a front-burner issue at several of the agencies, despite the dependence that they have on advanced materials in carrying out the missions for their agencies. Simply stated, I was surprised to find that education and marketing were more required among the agencies than with OMB.

Now let me address the FCCSET process from the perspective of the Assistant Director for Engineering. Until the fiscal year 1993 budget request, the Engineering Directorate has simply not been affected directly by the FCCSET process. The global change research, high-performance computing and communications, and math and science education FCCSET initiatives did not include the Engineering Directorate.

However, for fiscal year 1993, it is planned for the Engineering Directorate to participate in High-Performance Computing and Communication, plus the strong participation in both Biotechnology and Advanced Materials and Processing will involve the Engineering Directorate.

Although the first three initiatives did not affect the Engineering Directorate directly, they did have an impact on the engineering research community. However, because of the zero-sum nature of the budget process, some felt that the increase in resources for the initiatives would result in fewer resources for directorates not included in the initiative. In fact, you have touched on that here today.

Well, based on what I saw in my experience at NSF, I am not persuaded that NSF's participation in the FCCSET process adversely affected the resource allocation processes within the Foundation. Instead, it appeared that the FCCSET process was beneficial for NSF and the community it serves.

In its fiscal year 1992 budget request, NSF included a new research initiative on Materials Synthesis and Processing. It was a precursor to the Advanced Materials and Processing initiative announced this year. When I met with OMB to describe the MS&P initiative, I indicated then that we wanted to put it in a position so that NSF would be a precursor—would be the stalkinghorse, was the term that I used—for a possible Presidential initiative in fiscal year 1993.

Have the FCCSET initiatives imposed priorities on NSF? To the contrary, I believe that NSF has, in a sense, imposed its priorities on the FCCSET process. In fact, if you look at those areas that are being supported in FCCSET, they were already high-priority areas for the National Science Foundation.

Because NSF had it as a budget priority, did something in anticipation of that, they were in a position to articulate a very strong scientific agenda that in fact was compelling within the FCCSET process. So NSF, in a sense, has played a far stronger role within the FCCSET process than one might expect from an agency with its budget.

In a sense, as I say, the FCCSET process is an endorsement of the prioritization that has occurred within NSF. Furthermore, the prioritization within NSF has been bottom up rather than top down. It was not something that was imposed by the director but, rather, tended to result because of program directors and division directors articulating a need, making the case, and in all cases, that was predicated on very strong input from the scientific and engineering research community.

Perhaps you noted that an advanced manufacturing initiative is included in NSF's fiscal year 1993 budget request. This is consistent with what has happened in previous years. It is in fact expected that manufacturing might become a fiscal year 1994 Presidential initiative, and so NSF is trying to again be in the lead—be in anticipation of that, to be out front.

Now, I might parenthetically remind the subcommittee that, if you are not aware of it, there is a real struggle within the Federal Government about support for manufacturing education research. If you are not aware of that, I would encourage you to become familiar with the recent history involving the Department of Defense and the Armed Services Committee.

Attempts by the Senate to encourage DOD to support manufacturing education and research in colleges and universities have been singularly unsuccessful. I think it is time to conclude that the DOD horse is simply not going to drink from the manufacturing education and research bucket. To mix metaphors, that dog won't hunt.

NSF has demonstrated a commitment to manufacturing education and research, and I believe that Congress should ride NSF's horse if it is truly interested in strengthening manufacturing education and research in the Nation's colleges and universities.

Back in 1989, when I presented my first five-year plan to the then-NSF director, Erich Bloch, I indicated that two thematic research priorities would exist during my tenure as assistant director. They would be advanced materials processing, and environment and technology.

These were chosen on the basis of inputs from program officers, advisory committees, and various reports from the National Research Council. In fact, the initiative of advanced materials processing was selected to give me a two- pronged approach, processing of advanced materials and advanced processing of materials.

Interestingly, the Presidential initiative on Advanced Materials and Processing and NSF's Advanced Intelligent Manufacturing Systems initiative in the fiscal year 1993 budget request are consistent with that priority that I established in 1989.

The priority on the environment and technology is manifested in NSF's requested increase of $118 million for multidisciplinary research on the environment, and I expect to see continued emphasis on the environment and technology in future budget requests from the National Science Foundation.

Since returning to academe, I have been asked if the FCCSET initiatives are examples of top-down management of federally supported R&D. Well, I am not familiar with the details concerning all five initiatives and certainly not familiar with the Global Change Research initiative alluded to by Dr. Rowland.

I can certainly say in the case of Advanced Materials and Processing that it was not top down. In this case, the initiative was the result of enormous input from the private sector and academia. The foundation for that initiative, as well as NSF's MS&P initiative, was the National Research Council's 1989 report, "Manufacturing Science and Engineering for the 1990s: Maintaining Competitiveness in the Age of Materials", and in fact a co-chair on that study was Mert Fleming from MIT. Mark, I know you are familiar with him.

The report was the result of a multi-year effort of numerous individuals from academia, industry, and government. It was followed up by a series of four regional workshops to obtain input from a broad cross-section of engineers and scientists from industry and academe. From that, the initiative emerged. Far from being top down and an expression of bureaucratic priorities, the initiative represents the distillation of inputs from hundreds, if not thousands, of individual investigators.

On the one hand, the Federal Government has been criticized because its R&D investment is not coordinated. The charge has been made that there is a lack of communication between the right hand and the left hand, if not the right side of the aisle and the left side of the aisle.

Further, the criticism has been made that the Federal Government is trying to pick winners and losers through the FCCSET process. Far from the Federal Government picking winners and losers, I found that the FCCSET process provided a framework for coordinating the activities of multiple agencies to leverage Federal investments in R&D.

If the areas chosen for Presidential initiatives had differed substantially from those having high priority for NSF, I might have felt otherwise. However, it is difficult to envision topical areas emerging from the FCCSET process that are not priority areas for NSF. The emphasis NSF places on contributing to national competitiveness coincides with FCCSET's prioritization process.

I am sure the impact of the FCCSET initiatives on NSF is different from that on an agency that is not experiencing budget growth. The impact of the Presidential initiatives on NSF's discretionary R&D investments would be significant if budget increases did not occur and NSF attempted to participate at current levels.

However, the FCCSET process lets agencies decide whether or not to participate. I am not aware of any pressure from the Administration for an agency to participate beyond its means. In fact, because of overall budget constraints, the proposed levels of participation of DOD, DOE, the Bureau of Mines, and HHS are less than what I had anticipated in the materials initiative.

While on the subject, I should note that the resource allocation process used by FCCSET is my greatest area of concern. Two examples will illustrate the nature of that concern. The distribution of "new money" for the fiscal year 1993 request for the math and science education initiative resulted in the lion's share going to the Department of Education and relatively little going to NSF.

I would argue that the Department of Education is at least partially responsible for the Nation's inadequacies in math and science education and not the lack of money. It is not clear to me that depending on the Department of Education and the Nation's colleges of education to "solve the math and science education problem" is a wise decision; nevertheless, the FCCSET process resulted in $98 million of the $150 million being assigned to the Department of Education.

I am also concerned about NSF's small allocation for the biotech initiative. Because of the dominant role played by HHS, it is less likely that the non-health-related aspects of biotechnology, such as bioprocessing and biosensors, will receive the attention they deserve from a national competitiveness perspective.

My second example is one I cited previously, the inability of the Bureau of Mines, Department of Defense, and Department of Energy to participate in the advanced materials initiative at the levels I had envisioned. This caused the distribution of resources to differ from the initiative's research priorities.

Specifically, the mission agencies are responsible for the application-specific and material-specific research in synthesis and processing, with NSF being responsible for fundamental or generic research.

While the budget request for NSF is in line with the perceived need for fundamental or generic research, the requests for Defense, Energy, and Interior are less than envisioned in framing the initiative.

As evidence of my support for the FCCSET process, we are attempting to implement a similar process at my own institution to ensure that the various schools, laboratories, and colleges work together more closely. Georgia Tech's president has asked me to establish counterparts to the Steering Committee and Committee on Materials—or COMAT, as it is called—to ensure that our education and research activities in advanced materials are coordinated.

I have in my written testimony touched on a number of other concerns. But this morning, in talking with staff about some of the specific areas that they would like for me to touch on, let me in fact forgo commenting on any of these other areas and focus specifically on the issue of the selection process used by FCCSET. I am going to describe the activities that led to the biotechnology and advanced materials initiatives, in particular.

I served on the Committee on Industry and Technology that was chaired by Tom Murrin and currently chaired by Robert White, Under Secretary of Commerce. At our very first meeting as the Committee on Industry and Technology, each of the representatives from the agencies was asked to comment on those things that were of priority concern to them in the agency that would be candidates for consideration by our committee during the next couple of years or so.

Out of that, there were several topics mentioned: manufacturing, materials, machine translation, electronic devices, software, the environment, and biotechnology. A number of working groups were established by the chair. In fact, they had representation from a number of agencies. They were asked to look into these areas and to come back with a recommendation to the full Committee on Industry and Technology.

When it was reported back, it was obvious that the biotechnology one would be best handled by one of the FCCSET committees and that we should maintain a very close coordination with them. And Chuck Robb was in fact asked to do that. We found that coordination would be quite easy because, in fact, some people served on multiple committees within the FCCSET process, and furthermore, when you got back to the working level within the agencies, again you had the same people involved in those as they cut across these committees.

We then came together, and I was the one that was in fact chairing the steering group for materials. We made our recommendations to the committee. We gave a status report, and frankly, because the National Science Foundation had already been involved in its materials synthesis and processing initiative, we were further along than the other groups, and it was felt that our thinking was sufficiently developed in materials that we should in fact advance on to the next level.

Bob White than went before the full FCCSET Council and gave status reports for our work within the Industry and Technology Committee. And from that, the full FCCSET Council suggested that the materials initiative was the one that seemed to have most promise; for us to go back and to work on it and develop it and bring it forward in a more full-blown proposal for their consideration, which we did.

The same kind of thing was going on with other committees. And in fact, out of the one on life sciences came the one on biotechnology.

Another group that certainly has had an input in this process is PCAST, the President's Council of Advisors on Science and Technology, which consists again of people from the private sector as well as from academia, again very, very well qualified scientists serving on PCAST. They were giving the President as well as Dr. Bromley inputs relative to the candidates for possible FCCSET initiatives.

I would suggest that you invite OSTP to provide you with a flow chart as well as a narrative description on the process used to develop each of the five initiatives. I think that that would be helpful to you and would allay some of your fears and suspicions about the FCCSET process.

You asked me to comment on the issue of facilities, both academic facilities improvement and national facilities maintenance and modernization.

I noted that NSF did not request funds for academic facilities. Frankly, that is not surprising. The need is so great, the budget impact is so severe, that NSF continues to prefer to put its money where it can make the greatest difference.

However, as in previous years, I expect Congress will earmark money for academic facilities in NSF's budget. In a sense, they will take it out of their hide, and the amount available for research will be consequently reduced.

Now let's consider the large user facilities supported by NSF. While none of these were included in my budget—they are essentially to be found in the Math and Physical Sciences Directorate and in the Geosciences Directorate—I do have a feel for the continuing financial obligation represented by the telescopes, by the fleet, by NCAR, and so forth.

Currently, decisions regarding the fraction of NSF's budget that supports national facilities are made by the director, with input from the cognizant assistant directors. While the National Science Board considers the overall portfolio, I do not recall extensive discussions regarding the best way to treat national facilities in the budget request.

We have in fact each year put together for a five-or ten- year look into the future an estimate of what the total facilities cost would be for national user facilities.

I might also add, in response to your earlier question to the first panel, that these are in fact national user facilities, as opposed to those things that are uniquely at one university. These facilities are to be available to the broad community and in fact serve multiple institutions as opposed to being individual investments at individual locations for individual university use.

Individual board members on the Science Board, though, have expressed concern on a case-by-case basis regarding outyear obligations to major facilities. Because of their overall concerns, I was asked to develop a protocol to be used in treating renewals and recompeting user facilities, which I did and which is now in place with the National Science Board.

That would conclude my remarks, and I would be delighted to respond to the questions that you might have, as I said, on not only what I have touched on here but any aspect of my tenure at NSF.

Thank you.

[The prepared statement of Dr. White follows:]

Testimony of
John A. White
Dean, College of Engineering
Georgia Institute of Technology
before the
House Subcommittee on Science
February 25, 1992

Thank you for inviting me to appear before you today. As you may recall, I had occasion to appear before you last year as Acting Deputy Director of the National Science Foundation. After serving at NSF as Assistant Director for Engineering and Acting Deputy Director, I returned to Georgia Tech in September as Dean of Engineering. I mention this in order to establish the framework for my remarks regarding NSF's FY 1993 budget request.

I understand you are interested primarily in hearing from me regarding the impact of the Federal Coordinating Council on Science, Engineering, and Technology (FCCSET) process on the resource allocation decisions at individual agencies. In addition to commenting on NSF's budget request, I will cite some concerns I have regarding the NSF's budget request. If you have questions on any aspect of my tenure at NSF or NSF's budget, please do not refrain from delving into it.

FCCSET AND THE FEDERAL AGENCIES

A FCCSET Perspective

I will address the FCCSET process from both a FCCSET perspective and an agency perspective. As you may know, I chaired the Steering Committee for the Advanced Materials and Processing Program. In that capacity, I had occasion to work closely with the agencies, the Office of Management and Budget, and the Office of Science and Technology Policy. I came away from that experience with an appreciation for the complexity of the coordination process and considerable respect for the dedication of the people involved "to make the process work." While some were skeptical at the outset as to whether anything worthwhile would come from the FCCSET process, I believe all who worked on the advanced materials initiative were pleased with the outcome the first year and are optimistic that the five-year program will achieve its objectives.

Initially, I expected OMB would present the greatest challenge in designing the advanced materials initiative. I anticipated considerable resistance in defining the scope and the scale for the initiative. That was not the case! In fact, I found OMB to be extremely helpful throughout the process. Instead, the greatest difficulty was in gaining high level visibility and commitment to the initiative early in the budget cycle across all agencies. The subject of advanced materials was not on "the front burner" at several agencies, despite the dependence on materials in carrying out the missions of the agencies. Simply stated, I was surprised to find that education and marketing were required among the agencies, rather than OMB.

An Agency Perspective

Now, let me address the FCCSET process from the perspective of the Assistant Director for Engineering. Until the FY 1993 budget request, the Engineering Directorate was not affected directly by the FCCSET process. The Global Change Research, High Performance Computing and

Communication, and Math and Science Education FCCSET initiatives did not include the Engineering Directorate. However, for FY 1993 it is planned for the Engineering Directorate to participate in the High Performance Computing and Communication initiative. That participation, plus the participation in the proposed Biotechnology and Advanced Materials and Processing initiatives are the first to impact the Engineering Directorate.

Although the first three initiatives did not affect the Engineering Directorate directly, they had an impact on the engineering research community. However, because of the "zero-sum" nature of the budget process, some felt that the increase in resources for the initiatives would result in fewer resources for directorates not included in the initiative. With respect to the latter, I am not persuaded that NSF's participation in the FCCSET process adversely affected the resource allocation process within the Foundation. Instead, it appears that the FCCSET process has been beneficial for NSF and the community it serves.

In its FY 1992 budget request NSF included a new research initiative, Materials Synthesis and Processing (MS&P). It was a precursor to the Advanced Materials and Processing Program (AMPP). When I met with OMB to describe the MS&P initiative, I indicated we wanted to put it in place at NSF in FY 1992 in anticipation of a federal initiative in FY 1993.

Have the FCCSET initiatives imposed priorities on NSF? Interestingly, NSF gave a high priority to the subject areas for all five Presidential initiatives prior to them becoming interagency activities. In a sense, the FCCSET process is an endorsement for the prioritization that has occurred within NSF. Furthermore, the prioritization within NSF has been "bottom up" rather than "top down."

Perhaps you noted an advanced manufacturing initiative is included in NSF's FY 1993 budget request. As with the other initiatives, it is designed to meet a critical national R&D need; further, there is an expectation that it might become an interagency Presidential initiative in FY 1994. The emphasis on manufacturing R&D is not new to NSF. However, this initiative brings together multiple directorates in focusing on manufacturing issues.

(In the event the Subcommittee members are unaware of the struggle to support manufacturing education and research, I encourage you to explore the recent history involving DOD and the Armed Services Committee. Attempts by the Senate to "encourage" DOD to support manufacturing education and research in colleges and universities have been singularly unsuccessful. I think it is time to conclude that the DOD "horse" is simply not going to "drink" from the manufacturing education and research "bucket." NSF has demonstrated a commitment to manufacturing education and research; I believe Congress should ride NSF's "horse" if it is truly interested in strengthening manufacturing education and research in the nation's colleges and universities.)

In presenting my first 5-year plan to NSF's Director, Erich Bloch, I indicated the two thematic research priorities during my tenure as Assistant Director would be advanced materials processing and the environment and technology. These were chosen on the basis of input from the program officers, advisory committees, and various reports from the National Research Council. The former was intended to include processing of advanced materials (where the emphasis was on advanced materials R&D) and advanced processing of materials (where the emphasis was on advanced processing and manufacturing). The priority articulated in 1989 is manifested in the President's Advanced Materials and Processing Program and NSF's Advanced Intelligent Manufacturing Systems initiative. The latter priority on the environment and technology is manifested in NSF's requested increase of $118 million for multidisciplinary research on the environment. During the 1990s, I expect to see continued emphasis on the environment and technology in NSF's budget.

Since returning to academe, I have been asked if the FCCSET initiatives are examples of "top down" management of federally supported R&D. While I am not familiar with the details concerning all five initiatives, I can comment on the Advanced Materials and Processing initiative. In this case, the initiative is the result of enormous input from the private sector and academia. The foundation for AMPP (and NSF's MS&P initiative) is the National Research Council's 1989 report *Manufacturing Science and Engineering for the 1990s: Maintaining Competitiveness in the Age of Materials*. The report was the result of a multi-year effort of numerous individuals from academia, industry, and government. It was followed up by a series of four regional workshops to obtain input from a broad cross-section of managers, engineers, and scientists from industry and academe. From this, the AMPP emerged. Far from being "top down" and an expression of bureaucratic priorities, the initiative represents the distillation of inputs from hundreds of individual investigators.

On the one hand, the Federal Government has been criticized because its R&D investment "is not coordinated;" the charge has been made that there is a lack of communication between the "right hand" and the "left hand." Further, the criticism has been made that the Federal Government is trying to "pick winners and losers" through the FCCSET process. Far from the Federal Government picking winners and losers, I found that the FCCSET process provided a framework for coordinating the activities of multiple agencies to leverage federal investments in R&D. If the areas chosen for Presidential Initiatives had differed substantially from those having high priority for NSF, I might have felt otherwise. However, it is difficult to envision topical areas emerging from the FCCSET process that are not priority areas for NSF. The emphasis NSF places on contributing to national competitiveness coincides with FCCSET's prioritization process.

I am sure the impact of the FCCSET initiatives on NSF is different from that on an agency that has not experienced budget growth. Although the impact of the Presidential initiatives on NSF's "discretionary" R&D investments would be significant if budget increases did not occur *and NSF attempted to participate at current levels*, a guiding principle of the FCCSET process is that agencies choose to participate. I am not aware of any pressure from the administration for an agency to participate beyond "its means." In fact, because of overall budget constraints, the proposed levels of participation of DOD, DOE, and HHS are less than what I had anticipated.

In fact, the resource allocation process used by FCCSET is my greatest area of concern. Two examples will illustrate my concern. The distribution of "new money" for the FY 1993 request for the Math and Science Education initiative resulted in the "lion's share" going to the Department of Education and relatively little going to NSF. Yet, I would argue that the Department of Education is at least partially responsible for the nation's inadequacies in math and science education. It is not clear to me that depending on the Department of Education and the nation's colleges of education to "solve the math and science education problem" is a wise decision; nevertheless, the FCCSET process resulted in $98 million of the $150 million being "assigned" to the Department of Education. (A related concern exists relative to the relatively small allocation to NSF for the Biotechnology initiative. Because of the dominant role played by HHS in the initiative, it is less likely that non-health related aspects of biotechnology, e.g. bioprocessing and biosensors, will receive the attention they deserve from a national competitiveness perspective.)

My second example is one I cited previously, the inability of DOD and DOE to participate in the advanced materials initiative at the levels I had envisioned. This caused the distribution of resources to differ from the initiatives's research priorities. Specifically, the mission agencies are responsible for the application specific and material specific research in synthesis and processing, with NSF being responsible for fundamental or generic research. While the budget request for NSF is in line with the perceived need for fundamental or generic research, the requests for DOD and DOE are less than envisioned in framing the initiative.

As evidence of my support for the FCCSET process, we are attempting to implement a similar process at my own institution to ensure that the various schools, laboratories, and colleges work together more closely. Georgia Tech's President has asked me to establish counterparts to the Steering Committee and Coordinating Committee on Materials (COMAT) to ensure that our education and research activities in advanced materials are coordinated.

The increasing cost of technological and scientific research, coupled with the cross-disciplinary nature of the "most interesting" research problems, argues for leveraging and coordinating research investments. The FCCSET process demonstrates such leverage and coordination can occur in one of the largest and most complex organizations in the world -- the Federal Government.

FCCSET Selection Process

You asked me to comment on the selection process used by FCCSET. Since I am not familiar with the approach used for the other initiatives, I will limit my remarks to that used for the advanced materials initiative. At the first meeting of the FCCSET Committee on Industry and Technology (CIT) the chair, Tom Murrin, Deputy Secretary of Commerce, asked each agency to identify technologies of interest to them and having potential for interagency coordination. The emphasis was on improving the effectiveness and efficiency of federal investments in these technologies, not to surface candidates for budet enhancements.

Among the subjects cited at that meeting were advanced manufacturing, advanced materials, bitechnology, electronic devices, environmental impact of technology, machine translation, and software. Robert White, Under Secretary of Commerce for Technology, was given responsibility for organizing CIT's consideration of the technologies cited. Steering/working groups were formed, with the charge of assessing opportunities for interagency coordination. I was asked to chair the steering group on advanced materials. I don't recall who chaired all of the other groups, but I do recall that J. R. Thompson of NASA chaired the group that considered avanced manufacturing and John Lyons chaired the group that considered electronic devices.

At a subsequent meeting the groups reported to CIT their findings. Based on the level of activity among the agencies in advanced materials, as well as the existence of the Committee on Materials (COMAT) and NSF's FY 1992 Materials Synthesis and Processing initiative, it was concluded that advanced materials might merit consideration as a Presidential initiative for FY 1993. It was judged that biotechnology merited increased interagency coordination, but was expected to be the focus of the FCCSET committee dealing with the life sciences. Advanced manufacturing was another subject that was felt to merit increased emphasis, but more work was needed among the agencies in developing an agenda for coordination. The remaining technologies were judged to merit increased attention among the agencies, but did not merit consideration as Presidential initiatives.

By this point in time, Robert White was chairing CIT. In the spring of 1991 he presented a report to FCCSET and was encouraged to pursue advanced materials as a possible FY 1993 initiative. On that basis, my steering committee, together with COMAT, developed a proposal for an initiative in advanced materials and processing. In the process of developing the proposal, several meetings were held with OMB, OSTP, and agency representatives to clarify the scope and emphasis of the initiative. The proposal was submitted for review at the end of June. Terms of reference for the initiative were released by OMB in the summer and the FY 1993 budget request for advanced materials was submitted in September.

At intermediate points in the process, the President's Council of Advisors on Science and Technology (PCAST) and the National Critical Materials Committee (NCMC) were briefed on the status of the advanced materials initiative. Likewise, inputs to the process were provided by the chairs of four regional workshops that were held in conjunction with the National Research Council's report on materials science and engineering.

If you have further need for clarification concerning the selection process used by FCCSET, I suggest you invite OSTP to provide you with a flow chart and narrative description of the process used to develop each of the five initiatives.

CONCERNS

Academic Facilities and National User Facilities

You asked me to comment on the issue of facilities, both academic facilities improvement and national facilities maintenance and modernization. I want to add my encouragement to that provided by many others concerning NSF's support of infrastructure within the nation's colleges and universities. The combination of deteriorating facilities and laboratory equipment is one of the most serious issues facing higher education. The federal pressure to reduce indirect costs makes the situation even more precarious for the nation's research universities.

I noted that NSF did not request funds for academic facilities. Frankly, that is not surprising. The need is so great and the budget impact is so severe that anything SNF attempts to do in this arena will only scratch the surface. NSF continues to prefer to put its money where it can make the greatest difference. However, as in previous years, I expect Congress will earmark money for academic facilities in NSF's budget.

Now, let's consider the large user facilities supported by NSF. While none of these were included in my budget (they are essentially to be found in the Mathematical and Physical Sciences Directorate and Geosciences Directorate), I have a feel for the continuing financial obligation represented by the telescopes, research vessels, NCAR, etc. Currently, decisions regarding the fraction of NSF's budget that supports national facilities are made by the Director with input from the cognizant Assistant Director.

Although the National Science Board considers the overall portfolio, I do not recall extensive discussions regarding the best way to treat national facilities in the budget request. Individual board members expressed concerns on a case-by-case basis regarding out-year obligations of major facilities.

Due to a related concern, I was asked to develop a protocol to be used regarding renewing or recompeting major facilities grants. The National Science Board adopted the protocol, which essentially calls for recompeting major grants every ten years, with intermediate competitions possible if merited.

K though 12 and Undergraduate Education

I would be remiss if I did not mention some concerns I have regarding the National Science Foundation. The first concern relates to the tendency of Congress to compartmentalize what NSF does. While it would make life much easier for your staff for each NSF program to be independent from all other programs, the nature of education and research is that they are inseparable. Undergraduate and graduate student research, for example, are powerful vehicles for enhancing the quality of the educational experience. Many in higher education have discovered that treating education and research as independent activities has negative by-products. I believe the same is true for the National Science Foundation.

A number of NSF's new initiatives provide encouragement for the Principal Investigator to give greater attention to the teaching mission of the university. Further, the discipline based directorates have increased their investments in undergraduate education. (The Engineering Education Coalition program managed by the Engineering Directorate is one example of such an investment by a disciplinary directorate. Of interest to the Chair of the Subcommittee is the role played by Virginia Polytechnic Institute and State University in one of the new coalitions. However, while on the subject, I am disappointed NSF's request does not reflect a higher priority for undergraduate education. The budget request is inadequate in terms of the needs for curricular reform, laboratory improvement, and undergraduate teacher enhancement.)

Implicit in the decisions made by the Congress over the past several years is the belief that the nation's research universities do not have much to offer in improving math and science education in the nation's K through 12 education system. It appears that Congress believes the disciplinary directorates at NSF are not genuinely committed to improving precollege math and science education. I encourage you to convene a working meeting of the NSF Assistant Directors, your staff and the appropriations staff. Hear the Assistant Directors' ideas for enhancing the quality of math and science education. I believe you will be surprised at the depth of commitment across NSF to achieving the President's education goals for math and science. It is in higher education's self interest to have a strong K through 12 education system.

Human Resources

My remarks concerning education and research also apply to the issue of human resources development. The need for broadening participation of women, underrepresented minorities, and disabled persons in science and engineering is real and must be addressed in a more substantive way. Since 1986, the number of bachelors degrees in engineering has declined. This past year, 63,986 degrees were granted; whereas, 78,178 were granted in 1986[1]. In 1991, 15.65 percent of the bachelors degrees were awarded to women students, 3.6 percent were awarded to African American students, 4.2 percent were awarded to Hispanic American students, and 7.1 percent were awarded to foreign national students. (For the

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1 The statistics used are taken from *Engineering and Technology Degrees 1991*, published by the Engineering Manpower Commission of the American Association of Engineering Societies, Inc., Washington, D.C., 1991.

first time, the sum of degrees awarded to African American and Hispanic American students exceeded the number awarded to foreign national students.) While we can be pleased that the fraction of women, African American, and Hispanic American students receiving bachelors degrees in engineering is increasing, the increase in participation does not compensate for the decline in the size of the college age population nor the demographic shifts within that population.

Over the same period, the number of doctoral degrees granted in engineering increased from 3,686 to 5,680, with 73 percent of the increase due to foreign national students. In 1991, 51 percent of the doctorate degrees in engineering went to foreign national students, 9.7 percent went to women students, 0.75 percent went to African American students, and 0.9 percent went to Hispanic American students. With only 43 doctoral degrees granted to African American students in 1991, it is not surprising to find less than one African American faculty member in each of the nation's colleges of engineering. (If an institution awarded only one doctorate in engineering to an African American in the 1990-91 academic year, it would be ranked tenth nationally; if it awarded two, it would be ranked fourth nationally; if it awarded three, it would be ranked second; and if it awarded four, it would be ranked first nationally.

Clearly, we must recruit more American students to the nation's doctoral programs in engineering. (I believe NSF's new traineeship program will have a significant impact on the participation of American students in graduate education in engineering. For that reason, I was disappointed to find that no new resources are requested for FY 1993.)

Further, more must be done to encourage diversity among our engineering graduates. The issue of diversity in higher education is critical to the professional development of engineering students. As Dean of Engineering, I am responsible for providing the engineering students at Georgia Tech with a diverse faculty and a diverse student body to prepare them to be effective in professional practice. If any student is uncomfortable working with or taking classes from individuals who might differ in gender, skin color, or national origin, we must help them get over their discomfort while they are students. It is guaranteed that today's engineering graduates will work with individuals of different gender, skin color, and national origin; further, it is highly likely that they will report to such individuals during their professional career. Hence, it is in the students' self interests to "get over" any biases they might have while in the "protective environment" of higher education.

Before leaving the issue of human resources in engineering, I am compelled to address the so-called "engineering shortage" issue that has drawn so much attention in the past year. The issue revolves around semantics and misses completely the fact that no shortage will exist, because the demand for engineering talent will erode faster than the shrinkage in engineering majors. After all, there is no shortage of steel workers in the U.S. today. Neither is there a shortage of garment workers. The location of the demand for human resources moved to other countries.

Today, almost every U.S. corporation is contracting for engineering services overseas; many industry executives have told me they do so because they can obtain engineering designs faster, cheaper, and better than they can get in the U.S. Whether the contention is true or not, it cannot be denied that geographic proximity no longer provides a clear competitive advantage in the delivery of engineering services. With telecommunications, engineering designs can be provided as quickly from Hong Kong, Berlin, or Singapore as they can be provided from Palo Alto, Boston, or Atlanta. I hope you will be able to shift the focus on the issue from shortage to competitiveness of U.S. engineering and science.

The final arbiter will be quality, not quantity. We must ensure that our engineers and scientists are among the best educated in the world if we want to remain at the forefront of science and technology.

The Research Portfolio

A final concern relates to Congressional reaction to NSF's portfolio of research support mechanisms. Too much attention has been given to the "tension" between research by individual investigators and research within centers. The fact that those who perform research within centers are individual investigators is overlooked. The differences among the disciplines served by NSF, as well as the diversity within the R&D continuum, merit a rich portfolio. The Engineering Research Centers, Science and Technology Centers, Industry/University Cooperative Research Centers, and the State/Industry/University Cooperative Research Centers are valuable contributions to the nation's R&D capability. Finally, the impact of NSF's centers on undergraduate education should not be overlooked; it is impressive!

The centers created by NSF are being copied by other nations. We are at a point in time when strong incentives should be provided to stimulate cross-disciplinary, team oriented research on industrially relevant problems. I encourage you to be supportive of a portfolio at NSF that includes 50 percent of the research budget for individual investigator research, 30 percent for group research, and 20 percent for center research. Further, I encourage you to be supportive of the same portfolio being manifested within the Presidential initiatives.

NSF Staffing

Finally, I want to comment on NSF's budget request for increased staff. My three years at NSF occurred during a period of significant budget growth. As noted in the budget request, the size of the NSF staff has not kept pace with either budget growth or scope expansion at the Foundation. Of the two, the one that has had the greatest impact on staffing requirements is the addition of new initiatives, ones which require a different expertise from the staff. It is one thing to ask a Program Director to manage a program which experiences budget growth, but it is quite different to ask that same person to manage a program which expands in scope to include subjects outside his/her expertise. I encourage you to support the requested increase in salary and expenses to operate the Foundation. If such increases do not occur, I am afraid we will see either deteriorating quality or a substantive shift in how NSF operates.

CLOSING

Thank you for your attention and for permitting me to comment on NSF's budget request for FY 1993. If you have questions, I would be pleased to address them. Likewise, if you have further need of my input, please do not hesitate to contact me.

Mr. BOUCHER. Thank you very much, Dr. White.
Dr. Wulf?

STATEMENT OF WILLIAM A. WULF, PROFESSOR OF COMPUTER SCIENCE, UNIVERSITY OF VIRGINIA

Dr. WULF. First of all, Mr. Chairman, thank you very much for inviting me to be here. I appreciate the opportunity.

Having just listened to John's testimony, I am inclined to make mine rather brief and just say, "Me, too," because I agree with many of the things he said. So I think I will try to keep my remarks very brief and just focus on some things perhaps to amplify or clarify some things.

First of all, I am currently, as you said, a professor of computer science at the University of Virginia. I was previously an assistant director of the National Science Foundation. My responsibilities were for the Computer and Information Science and Engineering Directorate, which included the National Supercomputer Centers and the national network, NSFNet.

Before that, I was a professor at Carnegie Mellon and had started my own company and did that for about 10 years.

I say that because I want to reinforce a point that John made, and that is that many of us—in fact, about 30 percent of the staff at NSF—came from an academic background. We spend some period of time there and return. So when we talk about community representation, we should always remember that that representation is inside the Foundation as well as outside.

Speaking of the FCCSET initiatives, I would like to make several points. The first one is that, like John, I found the process to be enormously valuable. I served as chair of the Subcommittee on Networking, and I helped develop the High-Performance Computing and Communication initiative.

I thought the initiative provided both the opportunity and the need to do an in-depth analysis across the government of our funding and opportunities in high-performance computing.

One of the things that the whole process drove home to me was perhaps reinforcement of an attitude that I had previously, and that is the basic strength of the plurality of ways that science and technology is funded in this country. The various agencies with their different missions, their different styles, have different roles, and the process of coordinating those, I thought, reinforced in my mind, at least, the value of that plurality.

I frankly take umbrage at the notion that some people have put forward of a lack of community involvement. In the case of the high-performance computing initiative where I was involved, there were two boards of the National Research Council involved, at least two professional societies— EDUCOM, NASULGC, the Computing Research Association—at least a half-dozen different NSF panels, at least two studies by the Office of Technology Assessment, and on and on. We tried as best we could to get as broad an input as we possibly could to the process.

Moreover, it was not just in the process of formulating the initiative that we tried to get community input, but there has been an attempt to get continuing input. In the case of the national network, we have now created the Federal Network Advisory Council, I believe it is called, which is a private sector and academic organization to advise the government.

I happen to be on the NRC Computer Science and Telecommunications Board, and we are in an active process of discussing with the agencies ways in which we can help in the oversight of the ongoing process.

I think that we sometimes use the word "community"—the scientific community—as though it were a formal structure. It is not. It is a collection of fiercely individualistic people, some of whom are—you don't believe that, right?

Mr. NAGLE. When you said fiercely individualistic, I said, "Kind of like Congress."

[Laughter.]

Dr. WULF. Yes, sir.

Frankly, some of them are uncomfortable with the concept of priority setting, which was, I think, the greatest single benefit of the FCCSET process. Some of them object to any change, and some of them seem to confuse what gets funded with how it gets funded.

I think the consequence of the FCCSET process and the establishment of these initiatives, quite aside from the issue of additional money, was to set priorities, to decide what it was that was most opportune, how we could get the most bang for the buck.

Some folks seem to deduce from that that we have also decided to change how the funding will happen. One hears a lot of discussion about the value—and, believe me, I agree with this—of individual investigator grants. As Mr. Rowland observed before, the percentage of individual investigator grants in the initiatives is about the same as the percentage in the Foundation as a whole. That is, we have not changed the style, the mode of funding. We have simply focused on what it is that ought to be funded. Where are the opportunities?

I think there are at least three valid concerns that one should be careful about. One I have referred to as eating the seed corn. By their nature, these initiatives, I think, are opportunistic. They are an attempt to exploit past basic research to make significant social or scientific advances in a somewhat nearer term. In that sense, the overall initiatives, the government-wide initiatives, have a somewhat shorter time horizon than the traditional NSF basic research funding.

I think the way to deal with that concern is not to get rid of initiatives but to make sure that the initiatives concern themselves with the issue of basic research. I think that in the case of the High-Performance Computing and Communication initiative, where we have set 20 percent of the budget aside for basic research and human resources, we have done exactly the right thing in trying to replenish the seed corn. I think other initiatives would do well to emulate that approach.

I think the second concern is implicit in one of the questions that you asked us, and that is what I have called the success disaster. It is clearly too soon to tell whether any of these initiatives is a technical or scientific success, but they are widely perceived as a success in a way to extract funds from the Congress. One must be careful that we do not start creating initiatives just for that purpose. I think the right way to do that is for Congress to make sure that it continues to fund the base adequately.

The third concern is the issue of follow-through. In each of these initiatives, I think the potential for return is most likely to occur in the out-years. There is a very natural tendency in the political process for the glamor to wear off of an initiative after a few years. I think we must be very careful to make sure that that does not happen. We should first follow through on the initiatives that we have already started, and any new ones that we start, we should make sure we have a commitment to a long-term funding.

The question of what percentage of the NSF budget should be involved in initiatives seems to me to be a strange one. As new initiatives are proposed, I think they should be weighed on their own merits. Whether 40 percent is too much or too little is not the right question. The right question is, are the new initiative being brought forward the sorts of things that should be funded?

I think you should be concerned if the percentage of the budget devoted to initiatives is too small. If it is small, it implies that either the initiatives are very narrow or that the agencies really did not perceive them to be very important in the past. Remember, that 40 percent number includes all of the base budget that existed prior to the start of the initiative. That is two-thirds of it in the case of NSF and HPCC, for example.

I frankly feel somewhat comforted that 40 percent of the NSF budget is getting the kind of extra scrutiny that the interagency process tends to focus on it, the kind of not only scrutiny by the other agencies but by the scientific communities, the NRC, and so on.

So I would suggest that setting any particular percentage is just not the right thing to do. Rather, you ought to think in terms of whether a particular initiative is worth adding to the pot.

When staff asked me a little bit earlier whether I was going to say anything in my oral remarks about facilities, my reply was that I had opinions but not a lot of expertise. But I am a professor, and professors are allowed to express their opinions, so let me say just a couple of words.

The first one is simply to observe that here this morning, again, we seem to have the usual confusion between what is most often the congressional interpretation of the word "facilities"—namely, bricks and mortar—and what is very often the academic interpretation of the word "facilities," meaning instrumentation.

Let me deal with the two issues separately. In the case of instrumentation, I have a somewhat myopic view that resulted from being at NSF. There are, first of all, those instruments which are discipline specific and which were of concern to the assistant directors responsible for them. That seemed to me to be a perfectly appropriate mechanism. They support their individual investigators with that instrumentation just as we support individual investigators with direct grants. And it was up to those assistant directors to set the priorities between those two things.

I, however, was responsible for the National Supercomputer Centers and NSFNet, both of which were instruments, if you will, for the entire scientific community, or almost the entire scientific community.

There was, frankly, a strange tension between what appeared to be money in my budget versus money that would otherwise go to the budgets of the disciplines served by the supercomputer centers and NSFNet. That tension is not resolved, and I am not sure it ever will be, but it is different in kind than the individual discipline instrumentation.

On the issue of bricks and mortar, I think there is no one who will dispute the need. Whether the number is $10 billion or whether that number is a factor of 10 too small or too large, I haven't a clue. It is a serious need. There is no question about that. There is no question about the limitations that space and quality of facilities puts on every university I have visited.

The question that you asked earlier, Mr. Chairman, about whether we should try to pay for that by overhead recovery, political process, or peer review, if you state the question that way, I think everyone in the scientific community will vote for peer review. The question in my mind, however, is whether that should be NSF peer review.

NSF is a very special organization. It does what it does very well. Whether adding to it an inevitably politicized process would be a positive thing, I am very doubtful of. I do not know who should take care of this. I do not know which is the right agency, but I have a very strong feeling that NSF should be left to do what it does best.

Thank you.

[The prepared statement of Dr. Wulf follows:]

Testimony

Dr. William Wulf
Professor of Computer Science
University of Virginia

before the

Subcommittee on Science
Committee on Science, Space and Technology
United States House of Representatives

25 February 1992

Introduction

My name is William A.Wulf. I am currently a Professor of Computer Science at the University of Virginia. From 1988-90 I was an Assistant Director of the National Science Foundation, where I was responsible for the Directorate for Computer and Information Science and Engineering (CISE). I appreciate the opportunity to testify today.

Of the various questions posed in your invitation, I feel most qualified to address the issues of interagency initiatives. I was a member of the FCCSET subcommittee that drafted the High Performance Computing and Communication (HPCC) Initiative. I was a keen observer of the development of the Global Change Initiative, which preceded HPCC and in some ways served as a model for its development. I have not had the opportunity to observe the process of developing the Biotechnology and Advanced Materials Initiatives, however. I will focus my remarks on the two initiatives where I have some personal knowledge.

In at least these two cases I believe the process was an extremely positive one. Specifically in the case of the HPCC Initiative it provided both the framework and the impetus for an in-depth analysis and assessment of both extant programs and opportunities. To some extent it uncovered duplication, but more often it exposed gaps. It made us all appreciate the dramatic shift that has occurred in the application of computational techniques in science, and the enormous potential for the future. In the end, it made us grapple with the difficult issue of setting priorities.

I have long believed that the plurality of funding sources and styles is a basic strength of the US research enterprise; the process of developing the HPCC program reinforced that belief, and demonstrated how a coordinated program can exploit those differences. The assignment of responsibilities to Agencies in the HPCC program, for example, couples those best able to perform a given task with those who most need its result.

As had been the case in Global Change, a key aspect of the development of the HPCC Initiative was involvement of the community. Aspects of the program were considered by two National Research Council boards: the Computer Science and Technology Board, and the Board on Telecommunications and Computer Applications. Meetings and workshops were sponsored by EDUCOM, The Association for Computing Machinery, The Institute for Electrical and Electronic Engineers, the Computing Research Association, and the National Association of State Universities and Land Grant Colleges. A least a half dozen NSF Advisory Panels considered the program and provided input. The Office of Technology Assessment conducted studies of portions of the program. All of us involved in formulating the Initiative spoke wherever, whenever, and to whomever would listen, and tried to listen as attentively as possible to the feedback. I kept my own community informed through an electronic "newsletter" that went to every Computer Science and Computer Engineering department in the country.

As a member of several of these organizations, I can attest that their involvement continues to be aggressively sought by the participating agencies. The Computer Science and Telecommunications Board, for example, is currently exploring a number of options for providing independent oversight of the program.

For all that, it must be recognized that "the community" is not a formal structure, or even a particularly well defined one; "the community" cannot collectively take a position. Further, researchers are inherently fiercely individualistic. Not everyone paid attention, and not everyone agrees with the priorities we finally chose. Indeed, some scientists are not comfortable with the *concept* of priority setting. Others object to any change in the status quo.

I happen to disagree; I think that priority setting is a *responsibility* of the community, and it's especially healthy to conduct the process in the open. The process of developing these initiatives provides the context and need to assay competing ideas in the context of their cost as well as their merit. Resources are limited, and we cannot do all the things that we would like. I prefer a rational choice, openly made.

When discussing perceptions of the FCCSET Initiatives, it is helpful to carefully distinguish between *what* gets funded and *how* it is funded. In particular, the point of the exercise is to affect what gets funding -- to invest resources in solutions to specific, timely problems with high payoff. Some researchers jump to the conclusion that how they are funded is changed as well, and object based on this perception. While such a shift is certainly possible and perhaps even desirable in some cases, it need not be so. For example, contrary to perceptions, the proportion of HPCC funds at NSF used to support individual investigators is about the same as for the Foundation as a whole. Thus the mode of funding has not changed even though the areas have.

In short, I believe that at least the two initiative processes that I observed were exceptionally timely, useful ones with every expectation for high payoff. I do have some concerns, however.

- My first concern is the danger of "eating the seedcorn". Initiatives *should* target broad, but well defined problems with the property that success can be reasonably assumed. Of necessity, therefore, the complete program -- including the otehr agencies' responsibilities -- may have a closer horizon than the basic research traditionally funded by NSF alone. We need to be careful that initiatives don't "crowd out" the basic research that will lay the groundwork for future application.

  The right way to deal with this concern is *not* to eschew initiatives, but to build a basic research component into them. The HPCC Initiative, for example, devotes 20% of its resources to "basic research and human resources" -- that is, to replenishing the seedcorn. Other initiatives would do well to emulate this approach.

- My second concern is the "success disaster". Global Change and HPCC are too new to be judged to be technical successes -- but they *are already* perceived to be successes at garnering resources; I expect the new initiatives this year will be similarly perceived. If the base funding for science and technology visibly suffers as a consequence the various communities will deduce that initiatives are the only way to increase resources in their area.

  Fortunately, Congress can control this by ensuring adequate funding of the base. Specifically to the extent that initiatives do not specifically include base support, funding of the base is essential to replenishing the seedcorn.

- My final concern is related to the second. Often the payoff of an initiative comes in its later years -- so, once started, its important to carry through. Sometimes programs lose their glamor as they age; sadly this can happen to the most successful ones. Indeed, sometimes their very success makes them targets for special interests. I urge both the Administration and the Congress to continue their support of the existing initiatives; adding new ones should imply a resolve to long term support.

Having voiced these concerns, I suppose the inevitable question is "what proportion of the Foundation's budget should be associated with such initiatives?" The Committee's invitation mentions that over 40% on NSF's budget is programmed in the four current initiatives, with perhaps the implication that this is a too high. Alas, I don't have an answer to the question; indeed, I am not sure that the question is well formed.

I would, for example, be concerned if the proportion were small. That would suggest that the initiative areas were very narrow, that NSF had not previously thought them very important, or both. Taking HPCC as an example again -- it was picked precisely because of its broad impact on the infrastructure of science and engineering, and because we were already investing heavily in building the basic research that could now be exploited with a concerted "push". The "40%"

figure includes the previous base investment, and thus demonstrates to me the Foundation's commitment to the initiative areas. It also corroborates the broad impact these initiatives are having.

Frankly, I am also comforted that at least 40% of the budget has received the intense scrutiny that I know the HPCC research received over the process of developing the initiative. One of my strongest impressions of NSF is the integrity of both the people and the institution -- and the constant degree of self-analysis and critique that goes with that. While not particularly visible to the general public, nowhere is that integrity more evident than in the process of developing the Foundation's budget. Nonetheless, the additional independent critique by other agencies, the Academy, and other independent players that was part of developing the initiative was enormously beneficial.

In summary, while there exist issues that deserve vigilance, one of them is *not* the proportion of the Foundation's budget programmed in the four current initiatives. Moreover, the process that has lead to these initiatives should be viewed as providing a thorough vetting of both existing programs and agency plans in the target ares; as such they are an extremely positive development.

Thank you.

Mr. BOUCHER. Thank you very much, Dr. Wulf, Dr. White, and Dr. Wrighton. We appreciate your enlightening us today.

Dr. Wulf, let me simply pick up on that point. What commends the NSF peculiarly to me for the role of determining which projects should receive funding for facilities construction is the very expertise that you refer to and the fact that among the various federal agencies, this is the one that best understands the value of science research and can best pick among various projects in terms of relative merit.

And so, if not the NSF, then what agency? Do you have another recommendation as to who could do it better? Or should the FCCSET process begin to undertake that, as well?

Dr. WULF. I do not have an alternate candidate. I will observe, however, that in a very real sense, it is not the NSF expertise but it is the expertise of the community that NSF serves that you refer to. It is NSF's unique role to marshal those individuals to focus that expertise through its advisory committees and through its review process. But that could be done by another organization for this purpose.

Mr. BOUCHER. Well, if over time you have further recommendations as to how we should structure that, we would certainly welcome your advice.

Gentlemen, let me ask each of the three of you this question. I have heard each of you compliment in varying degrees the FCCSET process and talk about the value of that in terms of achieving the stated objectives. But I wonder if perhaps by devoting substantial funds—in this case, 40 percent of the NSF budget—to that, if you think perhaps there is a risk that we are underfunding some of the core research, understanding, of course, that core research does get funded as a part of these initiatives.

But is there a risk that there will be, as a consequence of 40 percent of these monies devoted to these initiatives, less monies available for funding unexpected opportunities as they arise and funding basic core research?

Dr. Wrighton, you specifically mentioned that we should not back away from the commitment to core research. Do you think we now are doing that?

Dr. WRIGHTON. Well, I think that there are opportunities in the core disciplines; yet, I think the flexibility in the system is considerable.

I served the NSF in the capacity of being an advisory committee member for chemistry and now materials research. The way I prefer to look at the four initiatives is to think of them as enhancements, and I would say, roughly speaking, we are looking at $50 million for each of the four initiatives.

These come in response to what I would refer to as proposal pressure. If you go into any of the divisions, which are the areas where these programs are really being coordinated through interactions with individuals and with labs and centers, you will find enormous proposal pressure in each of these areas.

What I think you and your colleagues should keep your eye on, really, is the notion that it is still a science community driven—it is an unusual community, rarely unified, but the community is applying a lot of pressure on the agencies coming forward with what

I think are outstanding ideas, and what you should shy away from is the support of areas, the support of goals, the support of objectives. What you really want to support are people and ideas.

Ideas and goals are not synonymous, and what we find in the scientific community now is an unprecedented era where people are coming forward with really outstanding ideas in very complex—unfortunately, relatively expensive—areas.

Mr. BOUCHER. Dr. White?

Dr. WHITE. I think the total amount of the request in fiscal year 1993 is greater than it would have been had it not been for the FCCSET process. In fact, if you look at what the OMB mark was for NSF and what came forward, it is greater than that initial mark.

Now, interestingly, the reason I think it is greater is because of what we called an above-the-line request on the advanced manufacturing initiative within NSF. Had that not been brought forward, had that not been put on the table as something that really merited attention, as well as the emphasis on the environment, the multidisciplinary approach on the environment, I think you might have found the fiscal year 1993 request both smaller and the fraction going for FCCSET much greater than the 40 percent.

I think the process is working. Again, you look at what is included in that, in the materials initiative, as an example, and every directorate except the Education and Human Resources Directorate and possibly Geosciences is involved in the materials. Heavy participation from the Division of Materials Research, as well as chemistry and mathematics, biology, engineering, computer science. There is a rich participation within that.

In fact, the precursor, the real precursor, to the materials initiatives, was a very small, little program that was started that was joint between the Chemistry Division, Materials Division, and the chemical engineering people. That proved to be so successful in terms of these communities coming together and working on problems—and the proposal pressure, as Mark suggested, was there, and then the NRC report came out, and there was all of this behind it—that I am not disturbed at all about the 40 percent, because I also know that there is 60 percent there that is not. And that 60 percent is actually quite a sizable amount of money.

In fact, frankly, because of the way the process is working, I would not be concerned if it were at 60 percent. I mean, I differ in what I think was the tenor of the participants on the first panel on this issue about individual investigator business.

I think that this committee in the past, and even now, focuses far more on process than on substance, and this business about being concerned about 40 percent and all, just like being concerned about centers versus individual investigators, completely missed the point that those people that are supported in the centers at MIT in their Engineering Research Center are outstanding individual investigators.

The same is true in the Science and Technology Centers, the S&T Center at Virginia Tech. Those are outstanding individual investigators who would have been supported, I believe, by the National Science Foundation if that STC had not gone to Virginia Tech. So I am concerned that we get into that.

Mr. BOUCHER. Let me point out that in asking these questions, we are not implying criticism of the decisions made. We are asking you who really have the expertise in this area what you think of those decisions and whether these are proper or not. So please do not assume that simply because we are asking you the question, we are saying it is wrong.

Dr. WHITE. No. I am responding, though, to the testimony of the previous panel

Mr. BOUCHER. Yes, I understand.

Dr. WHITE.—where they said maybe 25 percent would be better than the 40.

Mr. BOUCHER. You were suggesting that this subcommittee focuses too much on process. I disagree.

Dr. Wulf?

Dr. WULF. You asked whether there was a risk of underfunding. I do not think there is a risk; I think there is a fact. But the question is, is the cause the initiatives? I think the answer is no.

As I am sure you know, NSF keeps track of something that it calls the success ratio, roughly the percentage of grants which are funded. That number used to be around 40 percent for the Foundation. It as a whole has fallen to about 30 percent. In the CISE Directorate before I left, it was almost down to 25 percent.

There is no way to know exactly how many, of all the grants that come in, are fundable—that is, would really produce good science—but the conventional wisdom is that the number is around 50 percent. So there is a real per capita decrease in the funding available, and there is good science we are not doing because there is not money there to do it.

It seems to me what the FCCSET process does is focus our scarce resources where we have carefully analyzed that there is a potential for large payoff. If they made me king, I would fix the problem by upping the total budget, but that is not a choice I have.

Given what we could do, it seemed to me the smartest thing to do is to set priorities, and that is what we tried to do. Sure, there are some people, some areas that lose in that process, and they don't like it. And some people will not agree with the particular priorities we chose. But we did as thorough a job as I think could reasonably be done by a large set of people.

Mr. BOUCHER. So in providing that answer, it sounds that you are responding in the affirmative to what is the flip side of this question, and that is, does the FCCSET process hold the promise of an effective means of setting priorities in Federal research funding? And I gather you answer to that question is a very definite yes.

Dr. WULF. I think so, yes.

Mr. BOUCHER. Dr. White, do you agree as well?

Dr. WHITE. I certainly do.

Mr. BOUCHER. And Dr. Wrighton?

Dr. WRIGHTON. Yes.

Mr. BOUCHER. We do have unanimity on one key point.

Mr. NAGLE. Will the gentleman yield?

Mr. BOUCHER. I will be glad to yield to the gentleman from Iowa.

Mr. NAGLE. Dr. Wulf, one of the losers in this process, however, is the next pool of scientists. I mean, that is one of the down sides, isn't it? You are putting your money in these four projects, and you are saying that is where we are going to put the emphasis, and that is good for today. But in terms of the budget allocation for undergraduate research, for curriculum enhancement, for the development of the next generation of Ph.D.s, they don't really get the funding because of the decisions here. So we are going to win today and, in essence, one of the down sides is that we could very well lose a pool tomorrow.

Let me ask it more generically. You say some people are unhappy. Which of those people are unhappy, why, and where are they justified in their unhappiness and where are they not justified?

Dr. WULF. Let me respond to the first half of that question, if I may.

First of all, I can only speak from personal experience on the High-Performance Computing and Communication initiative, where we specifically set aside 20 percent of the budget for basic research and human resources.

Mr. NAGLE. I will give you a professor's license that you took earlier to express an opinion about the entire range and not simply limit it to your field.

Dr. WULF. Well, we scientists have this real hangup about trying to be accurate when we say things.

Mr. NAGLE. Think like a professor.

[Laughter.]

Dr. WULF. Let me just proceed along that. We set aside 20 percent of the initiative for basic research and human resources, and the phrase "human resources" is there very, very consciously. In the CISE Directorate, we spend something like 19 percent of our research funds on undergraduate educational activities.

So I do not think that the next generation is the loser in this process at all, at least from the piece of the pie that I can speak about authoritatively, and I think John would agree with that.

Dr. WHITE. Absolutely, in these fields.

Dr. WULF. Yes.

Mr. NAGLE. What about the other fields?

Dr. WULF. To my knowledge, we are not decreasing the funding in any other field.

Dr. WRIGHTON. I think there is some balance in the program, if I may speak, in the sense that all of the programs that are supported by the National Science Foundation do involve heavy components of the educational experience for the graduate students. Interestingly, the graduate students, of course, vote with their feet. Their interests are going to be reflected in the way in which they decide to pursue their own graduate studies and will sign up with the faculty members with whom they feel they are going to receive the most, both educationally and in terms of experiences.

The system is further balanced by the Foundation's programs for graduate fellowships, where, in essence, the resources are placed in the hands of the students and then they vote with their feet, irrespective of whether the faculty mentor has been successful in a competitive grants process.

So there is an opportunity for the graduate education experience to flourish, even though substantial resources are being directed toward the initiatives.

Mr. BOUCHER. That concludes the Chair's round of questions.

The gentleman from California, Mr. Packard.

Mr. PACKARD. Thank you, Mr. Chairman.

The budget proposal is to zero out the academic research facilities. Do you agree that that is an appropriate way to budget? In other words, do you support instrumentation more than you do facilities, or do you feel that there should be some of the budget devoted to the facilities?

Dr. White?

Dr. WHITE. I think that this is one of those things where no matter what you do, you are going to lose, or you could turn around and say no matter what you do, you are going to win. In this case, I think it is clear that they are going to lose. They are caught on the horns of a dilemma. How much do you ask for? No matter how much you ask for, it is not going to be enough. I mean, the problem is so big. And for the National Science Foundation to do that, they could have put—you have a certain amount that you can come forward in as your request, and you have that sort of OMB mark that you are dealing with. So you are trying to prioritize within that amount.

Suppose they had asked for $20 million. Well, it might have gotten up to $40 million. There is almost sort of a gaming going on here. But $20 million is just hardly scratching the surface.

So they said, if we had that $20 million, where would we rather put it? Where can we make the biggest difference? Because there is a multiplicity of needs out there. You go through these laboratories, and you are going to find obsolete equipment, you are going to find deteriorating conditions within the laboratories, to the same extent that you are going to find plaster falling down from the ceiling. You are going to find both of those situations.

So NSF says, okay, where can we make the most difference with our money? And the belief was, because of the leverage potential and everything else, that it is the instrumentation area, and I cannot fault that decision. I can speak for my own institution. We need help in both areas.

My fear is, frankly, that what is going to happen is the same thing that has happened the last couple of years. By the time it gets through the appropriations process, they are going to come out of it, and they are going to have facilities money in there. Their total request is going to be reduced.

Mr. PACKARD. Does NSF call upon the research community and the universities in terms of helping to develop their priorities?

Dr. WHITE. On that particular one, there have been meetings involving like presidents. There have been discussions through the advisory committees, certainly with the Science Board, about how to do that. There have been regional workshops. The problem on this is that, frankly, no matter what you put on the agenda, you have far more that are favoring yes, yes, we want you to do that, we want you to do that. The prioritization part of it has not been very successful.

I was delighted to hear from the previous panel a willingness to prioritize because, frankly, all of my attempts to get the community to do that met with failure; that they would come through and give you a laundry list, and all of their children were equally ranked, and they would not prioritize in the way that was needed. I am afraid that I cannot be very optimistic about that, Mr. Packard.

Mr. PACKARD. Do you feel the same, Dr. Wrighton?

Dr. WRIGHTON. Well, last year, I have to say we were the good beneficiaries of the program to upgrade facilities. We did receive grant support to renovate a laboratory in civil engineering related to environment, and it was a good resource.

But at the same time, that program comes with a need for substantial cost sharing from the university, and as the person responsible for finding resources for such commitments, I found myself in the situation of having to come up with $500,000. Five hundred thousand dollars is a draw on endowment to the tune of $10 million.

If we had substantially more in the way of opportunities for cost sharing, we would find ourselves in some difficulty. So it is a two-edged sword.

However, I believe that if the Foundation or other agencies of the government were to come forward with substantial commitments of their own, I believe it would be easier for us to have the private sector assist us in coming up with the cost sharing.

We are in the midst now of a major construction project at MIT for a building dedicated to research in biology. It is a $70 million construction project. To this point, we are basically moving ahead with private resources.

We believe that it is a sufficiently important area of science for us where we have a leadership position, that we should invest. And to a degree the private sector has been supportive, and to a degree Federal sources would be useful, because we think we will have substantial private support which could come for the cost sharing.

So I think a qualitative improvement in the situation could come from adopting the White House Science Council report of 1986, which suggested a $500 million per year program with 50:50 cost sharing.

Mr. PACKARD. Dr. Wulf, do you believe that the facilities at most of our research universities are inadequate, or are they adequate, or do they hinder the progress of viable research, or are they adequate to accomplish the goals that we have in our research programs?

Dr. WULF. I commented before that the scientific community does not always speak with unanimity on various topics. This is perhaps one of the few where you can get something close to unanimity. I think there is absolutely no question about the need.

Let me point out, by the way, that the need is not just in the research facilities. Let's keep in mind that something like half of the undergraduates in science and engineering graduate from four-year colleges which do not necessarily have large research programs and which also have severe facilities concerns.

So I think the issue of need is clearly there. The question that I come down quite differently, perhaps, than others on is I simply do not think NSF is the right organization to channel those funds through.

Mr. PACKARD. I thank you, Mr. Chairman.

Mr. BOUCHER. The Chair thanks the gentleman and expresses the thanks of the subcommittee to this panel for its testimony here this morning.

The subcommittee will now proceed to the third panel: Dr. Lynn Glass, the president of the National Science Teachers Association; Dr. Thomas Moss, Dean of Graduate Studies and Research at Case Western Reserve University; and Dr. John Leppert, the director of the Office of Science Education Improvement for the Florida Department of Education.

Mr. NAGLE. Mr. Chairman?

Mr. BOUCHER. The gentleman from Iowa.

Mr. NAGLE. I know now why the chairman is the chairman of the committee, because he obviously anticipated that I would not have any questions worthwhile.

Mr. BOUCHER. Oh, I am sorry.

Mr. NAGLE. But let me state that I enjoyed—I want to comment just briefly that I think the panel did fairly state and crystallize the issue for us, and I found their testimony most valuable. And with that, I yield back the balance of the time that I did not have. [Laughter.]

Mr. BOUCHER. The Chair expresses profound apologies to the gentleman. Given the time pressures we have, I totally overlooked the fact that it was his turn to propound questions, and if he would like the record kept open for the purpose of submitting them, we will be happy to do that.

The subcommittee would ask that these witnesses please keep their statements to five minutes because we now are under some time pressure.

Dr. Glass, we would be happy to begin with you, sir.

STATEMENT OF LYNN W. GLASS, PRESIDENT, NATIONAL SCIENCE TEACHERS ASSOCIATION; AND PROFESSOR OF SCIENCE EDUCATION, IOWA STATE UNIVERSITY

Dr. GLASS. It is a pleasure to be here, Chairman Boucher and Congressman Nagle, as well as other members of the committee.

I want to thank you, Congressman Boucher, for helping NSTA yesterday host a Japanese delegation from Toshiba. I think it recognizes your recognition of problems facing science education in America and actively seeking solutions to that, and that is very commendable.

I would like to limit my comments very briefly; my written record, I think, is sufficient.

The Education and Human Resources Directorate has always been a leader in the improvement of math and science education. Numerous State and local leaders attest to this as I travel throughout the country. I think NSF has touched the lives of millions of children through these dedicated teachers, these programs that began in the late 1950s.

If, however, Education and Human Resources funds are properly leveraged—and that is a big "if" at the beginning of that statement—we will achieve world-class schools. The Federal Government cannot—and, indeed, should not—try to support education.

Instead, agencies like the NSF need to serve as a catalyst for change. They need to provide the risk money to get things going.

I would like to comment on three of the areas that are in the reorganization of the Education and Human Resources Directorate, the systemic reform subactivity. First of all, it is an extremely popular activity. It is the talk of the town, one might say. It has generated interaction that has not taken place before, even in nonfunded States.

The State of Iowa is a good example. We have not been funded in the first two competitions, but we now have much conversation taking place between universities, both public and private, our State education agency, our local education agency, our area education agencies, as well as private business. So in that particular case, even with no Federal dollars expended, I think change is taking place.

There is, however, though, a horrendous problem facing the systemic reform subactivity, and that is that it is too big for Education and Human Resources to get its arms around. Science and math are two very small but important components to the total educational system. If we want kids to excel, to achieve, and to indeed reach world-class schools, we are going to have to create what I would call an ecology of achievement within our total educational system. English, history, vocational ed, fine arts, how we use teachers' time, administrative support, length of school day, length of school years are all types of things that must change if we are going to achieve world-class status.

Remember, when we find a good science program, we also find good programs in arts and the humanities and the social sciences, et cetera. Students are not stimulated to achieve one period of the day in science and then permitted to become mediocre in their thinking the rest of the day. We must look at a total school change, not just a change in science programs.

To truly make an impact, Education and Human Resources will need to join forces with other agencies, and I would suggest to you that an excellent candidate for this is the Department of Education. Once an ecology of achievement is established in a school, change will come about in science and mathematics as well.

The second area I would like to comment on is the elementary and secondary education subactivity area that combines many of the current programs that we have in the NSF. It is a needed and a popular area and one of the areas I would like to submit to the record.

Unfortunately, Congressman Nagle has left, but within his own home district is a program called Scope, Sequence and Coordination, which is curriculum development and teacher enhancement. It is operating in Davenport, Iowa, under the direction of the University of Iowa and coordinated by the National Science Teachers Association.

The third area I would like to comment on, the third subactivity, is undergraduate education. Much attention, and very deservedly so, has been focused on the poor content preparation of our science teachers. However, we will not solve our problem by creating more junior scientists. A sequence of courses which culminates in an esoteric Ph.D. will not make for better junior high science teaching, those years in which we begin to lose large numbers of our students.

Preservice teachers need broad preparation in several disciplines in an integrated and applied format, and we feel very strongly that this can best be done in the elementary- secondary division and not in the pipeline division where it is presently at.

Thank you for giving me an opportunity to share my remarks with you. My written record contains the details.

[The prepared statement of Dr. Glass follows:]

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DATE: February 25, 1992

TO: Members of the Committee on Science, Space, and Technology, U.S. House of Representatives

FROM: Lynn W. Glass
President, National Science Teachers Association

SUBJECT: Oversight hearing on Education and Human Resources (EHR) Directorate, National Science Foundation

Biographical Sketch:

Lynn W. Glass earned the Ph.D. degree in science education from the University of Iowa in 1970. Dr. Glass has taught middle school science, served as a science consultant for the Iowa Department of Education, and presently serves as a professor of science education at Iowa State University. He has directed 32 funded projects and has published 47 articles. His funded projects have dealt with teacher education, student research, and curriculum development. Dr. Glass has served in major leadership roles in several professional associations. He has served the National Science Teachers Association (NSTA) in numerous ways, including chairing a Search for Excellence in Science Education (SESE) program and serving on the Executive Committee of the NSTA Board of Directors. He currently is NSTA president. He is an elected Fellow in the American Association for the Advancement of Science and the Iowa Academy of Science. He has been President of the National Association of Academies of Science and has served on the Board of Directors of the School Science and Mathematics Association and the Association for the Education of Teachers of Science. Dr. Glass served for eleven years as biology editor for <u>School Science and Mathematics</u>.

Reorganization of the Education and Human Resources Directorate

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The improvement of our educational system has been a national priority for over a decade. The publication of A Nation at Risk, followed by an estimated 300 state, regional, and national study groups, has created an environment for change. The watershed commitment of President Bush and our nation's governors to putting education on the forefront of each state's agenda is unprecedented in our history. Against this background of commitment and change it is necessary for the National Science Foundation to bring about needed and significant reorganization of the Education and Human Resources (EHR) Directorate.

The National Science Teachers Association (NSTA) is the world's largest professional association dedicated to the improvement of science education at all levels. We view most of the proposed changes to be positive and needed. These changes will help us achieve world-class status in K-12 science and mathematics education. One proposed change, the undergraduate preparation of teachers, has serious flaws.

The most popular activity of the Education and Human Resources Directorate is encompassed in the new *Systemic Reform* division. Through regional and state conventions, I have been in close contact with teachers in approximately one-half of our states. The topic of Statewide Systemic Initiatives (SSI) often has been featured as a convention session. The sessions have been devoted to obtaining wide-spread input and ownership during the planning process as well as discussing how best to optimize the operation of an already funded project. One thing very clear is that this activity has caused diverse groups of professionals within the states to begin to work together to bring about mutually agreed upon change and improvement in K-12 science education. This is true, also, in many of the states which have not received SSI funding.

The greatest danger to the National Science Foundation (NSF) in this program is its political aspect. The fact is, the NSF lacks both the experience and the personnel to communicate and to work with state agency personnel. The National Science Foundation is connected most strongly to scientists in universities and has fairly weak links with the science education and teacher education communities. Many Statewide Systemic Initiative proposals have originated from the scientific or technological communities without consulting experts in science and mathematics education within the states involved. Statewide change is destined to fail without the support and involvement of the science and mathematics education communities.

Statewide Systemic Initiatives should involve much more than science or mathematics education. In systemic change teacher credentialing, school structure, administrative organization, state support of education, graduation requirements, and a variety of other problems within the system also must change. These changes require the coordinated efforts of the state department of education, teacher preparation institutions, local and regional educational agencies, professional scientific associations, and private sector interests.

The "medication" provided by the Statewide Systemic Initiative effort is analogous to a broad-range antibiotic -- designed to cure the problems of a sparsely populated state as well as those of a highly urban state where concentrations of minorities are found, and all for the same price, $10M. This initiative is neglecting seriously the problems of our large urban states while at the same time concentrating large amounts of funding in rural areas.

Perhaps the Statewide Systemic Initiative program should be co-supported by the Department of Education. Those parts of the systemic change equation concerned with science and mathematics and also requiring strong involvement of the college and university science education and teacher education communities could be funded by the National Science Foundation. The Statewide Systemic Initiative should be viewed as an *umbrella* for all Education and Human Resources Directorate activities. A truly systemic reform effort should involve all the present National Science Foundation efforts in undergraduate teacher preparation, teacher enhancement, materials development, access for women and minorities, research, evaluation, and dissemination. The portion of this effort in the National Science Foundation must be coordinated with every other Education and Human Resources activity; perhaps the division should be staffed entirely by persons who have joint responsibilities with the other Education and Human Resources divisions.

Consolidation of K-12 teacher enhancement and materials development into one division, ***Elementary and Secondary Education***, is an excellent and needed change. Few projects that are materials development can be completed successfully without also involving teacher enhancement; indeed, development in the context of teacher enhancement is the best model. One of the major lessons we learned in the post-Sputnik curriculum reform effort was that curriculum, no matter how good it might be, will not be incorporated successfully into the school program without appropriate teacher enhancement. Some of the most popular NSTA convention activities are those in which teachers get hands-on experiences with new curriculum materials, thus, providing further evidence that this move to consolidate is needed and appropriate.

The inclusion of the Presidential Awards for Excellence in Science and Mathematics Teaching and Young Scholars further coordinates and refines the way in which the Education and Human Resources Directorate works with our K-12 school programs. The Presidential Awardees are a rich and valuable resource. They need to be included in the very fabric of this division's activities. Throughout the United States we see the involvement of these awardees in a wide-variety of science and mathematics education improvement activities. These teachers need to be involved more systematically in efforts to improve the quality of our K-12 science and mathematics education. The activities we stimulate and fund through the Young Scholars should be a natural outgrowth of the type of activities we promote and fund for all youngsters. Being housed in one division should permit this needed articulation.

Informal Science education activities, as well as Private Sector Partnership activities, also should be designed to enhance and to build upon those activities we strive to achieve during the typical school day. Museums across the United States increasingly are working with schools. Seldom do we conduct a National Science Teachers Association convention without including museums in our offering of activities for teachers.

Within such a division, there should be sections devoted to different levels. The needs of pre-school, elementary, middle level, and secondary are quite distinct. Also the National Science Foundation staff expertise needed is quite different from one level to another. At the elementary level, we would like to see staff combinations like Alice Moses, a former elementary school science teacher, David Schidel, a scientist with experience in reform at the local district level, and Susan Snyder, a person with experience at the state level. These kinds of teams would help the new structure in Elementary and Secondary Education achieve the reform that is needed in K-12 education.

The ***Research, Evaluation, and Dissemination*** division is a much needed area of focus. Throughout the United States, I interact with teachers who are "reinventing" what already has been invented. Of even greater concern are those school districts employing practices which have been demonstrated to be inferior. Teaching and learning are the foundation stones upon which we must build effective curriculum and classroom strategies. The National Science Foundation is the only agency in the United States designed to fund a sustained and coordinated effort at unlocking the mystery of how we learn in the sciences.

We must be extremely careful not to design a division which will operate in isolation from the other activities of the Education and Human Resources Directorate. This is especially true with the Elementary and Secondary Education division. There must be explicit mechanisms that will ensure interactions between this division and other divisions in the

Directorate. One way to do this is to have one or more staff members working within two divisions.

Our greatest concern is the inclusion of undergraduate teacher preparation programs in the *Undergraduate Education* division rather than in the Elementary and Secondary Education division. It already has been noted that coordination of teacher enhancement and materials development is a logical and wise decision. It would seem to follow that preservice science teachers also should be prepared in a manner consistent with the expectations that we will have for them when they become practicing teachers.

With the proposed organization we are in danger of creating a new generation of teachers unable to teach the classroom materials we design. This decision could compound present problems with science teacher education by focusing too strongly on the subject matter required and needed by pipeline majors, a subject matter which is often inappropriate for teachers. For example, middle-level teachers need broad preparation in several disciplines and in an integrated and applied format. Almost all undergraduate efforts at the National Science Foundation are aimed at preparing specialists in the various fields and sub-fields of the science disciplines. This problem would be especially serious, if present staff were to be used, without the infusion of science education or teacher education persons who have expertise in precollege teacher education.

Mr. BOUCHER. Thank you, Dr. Glass.
Dr. Moss?

STATEMENT OF THOMAS H. MOSS, DEAN OF GRADUATE STUDIES AND RESEARCH, CASE WESTERN RESERVE UNIVERSITY

Dr. MOSS. Thank you, Mr. Chairman.

I thank the committee for its interest in the SSI program, which will be the focus of my remarks today, and I will summarize so there is time to discuss it with you.

Though by profession I am a dean at one of the Nation's research universities, the most important thing for today is that I have been working with Ohio's pilot district in its own SSI program. I also sit as a school board member in a very interesting educational community, Shaker Heights, which has both a great tradition of science and math education, 50 percent minority population, and was in fact the third ranking public school district in National Merit Scholar awards.

I want to make five key points today. One is that the SSI program is a very bold and, I think, very risky one for NSF to undertake. I would like to say why I think it is a useful one; second, comment on whether I really think we can do it and the stresses we are going to face—what it will take to succeed; and then a few words about Ohio's program in specifics.

The reason I call it a bold and risky program is that it is really turning away from the tradition of rather categorical Federal specific interventions in science and math education, things that we can see and measure very palpably, to challenging the States to create their whole new strategic structure for science and math education. It is a different role for the States than we are used to.

I see the SSI really as seed money to get us to think of our own strategy, to mobilize our own resources, to try to bring together a much bigger program than the SSI alone will fund for us.

The question of why to do it—I do not have to say why we have to do things about science and math education. This committee has been a leader in that role. Why to do it through the States? I think it is pretty clear that the States really have the communication links, the regulatory authority, the way to deal with local school boards that the Federal Government just does not have, and I think it is a fair challenge for the Congress to give to the States to see if we can come up with programs that are perhaps more effective than the programs of the past.

The most intriguing thing to me in thinking about our own SSI program as we have been designing it is whether we can do something in science and math education which is analogous to what we did in industrial innovation and university-industry relationships in the 1980s. The States —North Carolina with Research Triangle Park, Pennsylvania with Ben Franklin, Ohio with Thomas Alva Edison—came up with some extremely innovative programs in a time in the 1980s when the Federal Government was not able to really create programs to solve the national innovation program. I think NSF is challenging us to do a similar State-based strategy in science and math education now.

The question is, of course, can we do it? And what stresses are we going to face? I can say first hand about many of the stresses we are facing because we face them every day as we try to plan our program. It is not easy to get our own group to begin thinking long range and systemically. We tend to want to talk about administering a Federal program as opposed to setting in place a long-range strategy that is going to go on even beyond the duration of the Federal program in time and certainly beyond in resources.

Our own group likes to think of NSF having "solved" our program with the SSI award, when really, all they have done is given us a little seed stimulus to get us started on solving the program ourselves.

We also have to create the view that we are dealing with a community challenge, not just an education establishment challenge, because unless we can get the support of our foundation establishment, our business establishment, we are never going to succeed in the overall challenge.

Again, I as a school board member feel particularly that we have to get parents invested in this process. I hear very clearly if our parents are dissatisfied about spelling and reading literacy. I need to hear just as frequently about dissatisfaction about their kids' science and math literacy.

In terms of what it is going to take for us to succeed, I think it is obvious that we are going to need tremendously strong leadership from the governor and the top political leaders in the States to make it work. We have very complicated structures at the State level, just as you do at the Federal level, of diverse interests—Department of Education, regents, et cetera—and only the governors' full commitment will bring those units together.

In Ohio, we are fortunate because we have the director of the State Department of Education and the vice chancellor of the Regents as co-directors of our projects. But that is a rather unusual arrangement, and it is probably also, to be blunt, a fragile relationship. And we have to maintain that kind of thing.

The other thing that is going to be needed, I think, is going to be patience from both this committee, the Congress, from OMB, and from NSF itself. We are making a very big cultural change in the way we try to handle science and math education. It is not going to happen in a year. There are going to be lots of mistakes. If there are not mistakes, we are not being as bold as we ought to be in trying new approaches, and we are going to have to let these play out if we really want to see whether this was a good experiment or not.

I want to also stress the need for very strong oversight and what I would call nurturing of this program at NSF and beyond NSF to national bodies, because NSF alone cannot do it. I think the National Governors Association, the Conference of State Legislatures, and national science and math organizations are going to have to work with NSF in using this program to express some of the goals we have all felt to improve science and math education. After five years, we should have some models, but if we jump off the program too soon, we will never know whether it would have worked.

NSF is thinking clearly about technical assistance and things of this sort for the States. I think that is fine, but I would stress, also, that the real barriers are often institutional barriers. And what we States have to learn from each other is how we have broken down barriers between our departments of education, our regents, our industry, our universities, and so on. That is a little bit different than conventional terms of technical assistance, and I hope NSF will focus on those as well.

The Ohio program is focused—just so you have a picture of it—on middle school teachers and empowering them to teach in what we call inquiry-based science. I brought a little bag of nuts and bolts and a lesson plan, which I will turn over to counsel for the record, however he wants to put it into the record.

One of the first things it says is, "First step: Throw out the instructions." So that tells you, perhaps, one of the approaches.

The goal really is to help students think and reason, not to focus on content, not on terms, not on vocabulary words. We are very fortunate in Ohio to have unparalleled leadership. We have Dr. Ken Wilson, who is a Nobel Laureate in physics at Ohio State, and Dr. Jane Butler Kahle, an international scholar in science education, as our co-PIs, and then the vice chancellor and director of the Department of Education as project leaders.

We have, interestingly enough, a regionalized structure in Ohio, eight regions, which kind of mirrors NSF's problem. They have 50 States to deal with eventually, if they go that far. We have eight regions. We have to knit them into some kind of coherent whole and establish communication between them. So we will be working with the same oversight problem that NSF itself will have.

Our Ohio program is also very much oriented to try to strengthen the participation in science and mathematics by females and underrepresented minority groups. We believe that this Discovery approach, the inquiry-based learning that I mentioned, will encompass more learning styles than many of the traditional ways of teaching science and mathematics and that we will be able to draw students in who might have been culled out of the system at early ages. It really is a picture of trying to create science courses that are magnets rather than filters for people who are interested in science.

Our program also is going to work on a notion of teacher leaders, teachers who are trained and then go to teach other teachers. But a more radical part of that is going to be what we call scientists and math educators. That is, university- based faculty whose main interest is not research, not getting new knowledge, but it is on bringing their field into precollege science and math education and understanding how young people learn at those ages. It is going to take us a lot of work to establish this as a professional ladder, and it is a very new concept.

We are trying to run our program as a total community project in northern Ohio. We have our foundations. We have our industry leaders involved. But I want to stress that this is the kind of thing—we have used the metaphor of a train with people jumping on and off the train depending on whether they are comfortable with the direction, and we constantly have trouble to try to knit our various interests together to carry out this program.

I do want to emphasize what the project is not, because there are political forces in Ohio, for instance, that would like it to be other things. It is not aimed at increasing the amount of content or facts or terms that we convey to our students, and it is not aimed at increasing scores on standardized tests, which are the rage in Ohio as they are in many other States.

It is aimed at making science and math more exciting to students, to drawing more kinds of students into science and math, and enabling them to understand science as they go into either their professional careers or just their lives in a technological world.

I hope our experience and our ideas are useful. The one thing I would do is urge the committee to check in on this program often in oversight fashion. It is going to be a program that is going to have some very interesting ups and downs. And I think, for all of us involved, our commitment to success will probably be heightened every time we hear that the committee is taking a particular interest in it.

So your interest will help us, and I would be glad to answer questions when we conclude the panel.

[The prepared statement of Dr. Moss follows:]

TESTIMONY, HOUSE SCIENCE, SPACE AND TECHNOLOGY COMMITTEE

THE NSF STATEWIDE SYSTEMIC INITIATIVE PROGRAM IN SCIENCE AND MATHEMATICS EDUCATION

THOMAS H. MOSS

CASE WESTERN RESERVE UNIVERSITY

WASHINGTON, DC, 2/25/92

I APPRECIATE THE COMMITTEE'S INTEREST IN THIS IMPORTANT AREA. I AM THE DEAN OF GRADUATE STUDIES AND RESEARCH AT CASE WESTERN RESERVE UNIVERSITY IN CLEVELAND OHIO, ONE OF THE NATION'S TOP 15 PRIVATE RESEARCH UNIVERSITIES IN LEVEL OF FEDERAL RESEARCH AWARDS. MORE IMPORTANT FOR THIS HEARING, I HAVE BEEN PART OF THE ADVISORY COMMITTEE FOR THE NORTHEAST OHIO PILOT REGION OF THE OHIO SSI PROJECT, "DISCOVERY" (ATTACHED BROCHURE). I AM ALSO AN ELECTED MEMBER OF THE SCHOOL BOARD OF SHAKER HEIGHTS, OHIO, AN EXCITING AND DIVERSE COMMUNITY WITH MORE THAN 50% MINORITY POPULATION IN ITS SCHOOLS, AND A RECORD OF ACADEMIC EXCELLENCE THAT PLACED US THIRD NATIONALLY AMONG PUBLIC SCHOOL SYSTEMS IN NATIONAL MERIT SCHOLAR RECOGNITION (N.Y. TIMES, ATTACHED). OUR COMMUNITY WILL BE AN ENTHUSIASTIC PARTICIPANT, IN PARTNERSHIP WITH CLEVELAND AND MANY OTHER NORTHEAST OHIO SCHOOL SYSTEMS, IN THE "DISCOVERY" PROJECT.

PERHAPS MOST IMPORTANT, I AM THE FATHER OR AFS FATHER OF FIVE VERY DIFFERENT YOUNG PEOPLE WHO HAVE RECENTLY GONE THROUGH THESE

SCHOOLS, AND HAVE SEEN VIVIDLY IN THAT PARENTAL ROLE MANY OF THE CURRENT PROBLEMS OF SCIENCE AND MATHEMATICS EDUCATION.

THOUGH I CERTAINLY REPRESENT THIS TESTIMONY AS MY OWN VIEW, I HAVE CONSULTED WITH OUR PROJECT AND COMMUNITY LEADERSHIP, AND OTHER SCIENCE AND MATHEMATICS EDUCATION COLLEAGUES, SO THAT WE COULD BRING YOU A PERSPECTIVE BROADER THAN WHAT WOULD HAVE BEEN MY OWN ALONE. I WANT TO ACKNOWLEDGE THE CONTRIBUTION OF THIS LARGER GROUP TO THE IDEAS BELOW.

I WILL FOCUS ON 5 KEY POINTS:

1. THE BOLD, SOMEWHAT RISKY, AND FUNDAMENTALLY NEW DIRECTION OF THE SSI PROGRAM COMPARED TO PAST FEDERAL APPROACHES TO SCIENCE AND MATHEMATICS EDUCATION.

2. WHY IT MAKES SENSE TO DO IT.

3. THE QUESTION OF WHETHER WE ARE CAPABLE OF CARRYING OUT THE STRATEGY, AND THE STRESSES WE WILL HAVE TO FACE.

4) WHAT WE WILL HAVE TO DO TO SUCCEED.

5) ASPECTS OF THE OHIO "DISCOVERY" PROJECT AS AN EXAMPLE OF THE NATIONAL PROGRAM.

1. THE NSF SSI PROGRAM REPRESENTS A MAJOR TURNING POINT IN THE HISTORY OF FEDERAL EFFORTS TO ENHANCE PRE-COLLEGE EDUCATION IN SCIENCE AND MATHEMATICS.

PAST PROGRAMS WERE LARGELY FEDERALLY DEFINED, WITH SUPPORT FOR RELATIVELY SHORT-TERM AND SPECIFIC ELEMENTS IN THE CONSTELLATION OF NEEDS (E.G. TECHNIQUE WORKSHOPS, LIMITED AND LOCAL CURRICULUM PROJECTS, ETC.) THE NEW PROGRAM CHALLENGES THE STATES TO COME UP WITH THEIR OWN STRATEGIES FOR COMPREHENSIVE, STATEWIDE, AND LONG-TERM SYSTEMIC CHANGE IN THEIR APPROACHES TO IMPROVE THE TEACHING OF SCIENCE AND MATHEMATICS (SEE NSF 5/14/91 ANNOUNCEMENT ATTACHED). THE FEDERAL FUNDING WILL REPRESENT A MAJOR CATALYST OF SEED FUNDING FOR SUCH MASSIVE CHANGE, BUT THE STATES WILL HAVE TO MOBILIZE AND BRING TOGETHER MANY OTHER PROGRAMS AND SUPPORT STRUCTURES TO ACCOMPLISH THE GOAL. NSF SHOULD AND WILL CONTINUE TO DIRECTLY SUPPORT NEEDED RESEARCH IN UNDERSTANDING HOW YOUNG PEOPLE CAN BEST BE REACHED BY SCIENCE AND MATHEMATICS INSTRUCTION, BUT THE IMPLEMENTATION STRATEGIES WILL BE CARRIED OUT BY THE STATES UNDER SSI.

2. WHY THIS APPROACH?

I KNOW THIS COMMITTEE IS WELL AWARE OF THE ENORMOUS NATIONAL NEED TO IMPROVE PRE-COLLEGE SCIENCE AND MATHEMATICS EDUCATION, AND HAS TAKEN A LEADERSHIP ROLE IN CALLING ATTENTION TO IT. IN THE UNIVERSITY AND TECHNOLOGICAL INNOVATION WORLDS WE FEEL THIS NEED PARTICULARLY IN THE SENSE OF TRAINING PROFESSIONALS AND

STRENGTHENING THE U.S. POSITION IN A VIGOROUSLY COMPETITIVE WORLD ECONOMY. AS A PARENT AND COMMUNITY EDUCATION OFFICIAL I FEEL IT IN THE SENSE OF EMPOWERING ALL OF OUR YOUNG PEOPLE SIMPLY TO LIVE SUCCESSFULLY IN AN INCREASING TECHNOLOGICAL WORLD.

THE SSI APPROACH REPRESENTS A MORE NATURAL AND EFFECTIVE FORM OF FEDERAL SCIENCE AND MATH EDUCATION INVOLVEMENT THAN THAT OF PAST PROGRAMS. STATES CONTROL MORE REGULATORY, FINANCING, AND COMMUNICATION TOOLS FOR THIS PURPOSE THAN DOES THE FEDERAL GOVERNMENT. STATES ARE GENERALLY IN CLOSE AND REGULAR COMMUNICATION WITH LOCAL SCHOOL DISTRICTS, AND ARE WELL AWARE OF THE STRENGTHS AND NEEDS AT THE OPERATIVE LOCAL LEVELS.

THE STATES HAVE ALREADY SHOWN GREAT ENERGY AND VITALITY IN TACKLING SOME NATIONAL-SCALE PROBLEMS OF THE '80'S. THE DRAMATIC EMERGENCE OF STATE-DESIGNED INDUSTRIAL INNOVATION PROGRAMS IS PERHAPS THE BEST EXAMPLE. THE NSF SSI PROGRAM CHALLENGES THE STATES TO MOBILIZE THE SAME LEVEL OF COMMITMENT, VITALITY AND CREATIVITY IN THIS AREA AS THEY DID FOR INNOVATION AND COMPETITIVENESS WITH PROGRAMS SUCH AS NORTH CAROLINA'S RESEARCH TRIANGLE PARK, THE PENNSYLVANIA BEN FRANKLIN PROGRAM, AND OHIO'S THOMAS ALVA EDISON PROGRAM.

3. CAN WE DO IT? STRESSES AND PROBLEMS WE WILL HAVE TO DEAL WITH:

MOST FUNDAMENTALLY WILL BE THE PROBLEM OF GETTING ALL INVOLVED TO THINK LONG-RANGE AND STRATEGICALLY, NOT JUST ON THE SCALE OF ADMINISTERING THE CURRENT SSI AWARD. THOUGH THEY

REPRESENT A MAJOR NSF COMMITMENT, SSI FUNDS AND PROJECTS ARE ONLY A FRACTION OF THE EFFORT NEEDED TO CREATE COMPREHENSIVE, SYSTEMIC CHANGE. IN OUR REGION OF OHIO, "DISCOVERY" FUNDS MAY ONLY BE SUFFICIENT TO FULLY TRAIN 12-16 "TEACHER-LEADERS" OUT OF A SCIENCE AND MATH TEACHER POPULATION OF OVER 1000. THAT WILL BE A START, BUT EVENTUAL SUCCESS WILL DEPEND ENORMOUSLY ON OUR LOCAL ABILITY TO PROPAGATE AND MOBILIZE THOSE SKILLS AND NEW IDEAS ON A MUCH BROADER SCALE. OUR STATE PLANNING AND STRATEGY GROUPS WILL HAVE TO REALIZE THAT NSF HAS NOT "SOLVED" OUR PROBLEM FOR US, BUT HAS GIVEN US A STIMULUS AND SOME SEED RESOURCES TO GET US STARTED TOWARD SOLVING IT OURSELVES. IT IS A DAUNTING CHALLENGE. WE WILL HAVE TO MAKE UNPRECEDENTED EFFORTS TO LINK DIVERSE PROGRAMS AND CENTERS OF VITALITY TOGETHER IN SYNERGISTIC WAYS, AND WE AND NSF MUST THINK CONSTANTLY ABOUT LEVERAGING MUCH LARGER RESOURCES WITH THE CURRENTLY AVAILABLE FUNDS, AND OF SUSTAINING PROMISING CHANGE BEYOND THE SSI GRANT LIFETIME.

IT IS A TEMPTING AND SOMEWHAT CONDITIONED BEHAVIOR FOR US LOCALLY TO THINK OF THIS PROJECT AS ONE OF "ADMINISTERING" FEDERAL AND STATE FUNDS. OUR TOUGHEST CHALLENGE IS TO SHAKE OURSELVES OUT OF THAT FRAME OF MIND AND INTO THE REALIZATION THAT IT IS OUR RESPONSIBILITY TO CREATE THE SYSTEMIC CHANGES WITH THE STIMULUS OF THE NEW RESOURCES.

ANOTHER SHIFT WE MUST MAKE IN OUR LOCAL IMPLEMENTATION POINT OF VIEW IS AWAY FROM THE IDEA THAT THIS IS JUST A SCHOOL OR EDUCATION ESTABLISHMENT PROBLEM, AND TO THE NOTION THAT IT IS A CHALLENGE FOR OUR ENTIRE COMMUNITY. BUSINESS, LOCAL FOUNDATIONS, COLLEGES AND UNIVERSITIES, AND EMPLOYERS WILL HAVE TO BOTH DEMAND

<u>AND SUPPORT</u> SUCH CHANGE AS PART OF THEIR EXPECTATIONS OF A VIABLE PUBLIC EDUCATION SYSTEM. WE MUST ALSO SUCCEED IN INVESTING PARENTS STRONGLY IN THE CHANGE PROCESS. AS A SCHOOL BOARD MEMBER I HAVE ALWAYS KNOWN I WOULD HEAR CLEARLY FROM OUR DISTRICT PARENTS IF THEY SENSED THEIR CHILDREN WERE NOT LEARNING TO READ AND SPELL AT ADEQUATE LEVELS. WE WILL NEED THEM TO BECOME EQUALLY IMPATIENT WITH ANY LACK OF ACHIEVEMENT IN SCIENCE AND MATHEMATICS LITERACY, INSTEAD OF EXCUSING IT WITH THE NOTION THAT "SCIENCE AND MATH WAS ALWAYS HARD FOR ME TOO".

WE WILL ALSO HAVE TO OVERCOME THE STRESS, FATIGUE AND CYNICISM BUILT UP IN TEACHERS AND SCHOOL ADMINISTRATORS BY YEARS OF OFTEN-POLITICIZED PUBLIC EXPECTATIONS, COUPLED WITH MINIMAL COMMITMENT OF POLITICAL SUPPORT. THERE IS ALSO THE INERTIAL DRAG OF ENTRENCHED STERILE CURRICULA, VOCABULARY-BASED TEXTBOOKS, AND THE DEADENING EFFECT OF SIMPLISTIC APPROACHES TO STANDARDIZED TESTING. ANALYSES OF THE NUMBER OF VOCABULARY WORDS EXPECTED TO BE LEARNED IN TYPICAL SCHOOL SCIENCE TEXTS VS. THE NUMBER IN A FIRST YEAR FOREIGN LANGUAGE COURSE HAVE SHOWN THE NUMBERS TO BE SIMILAR. THAT IS NOT THE WAY TO CREATE EXCITEMENT FOR SCIENCE IN OUR YOUNG PEOPLE. THE NOTION THAT STANDARDIZED TESTING IS AN INEXPENSIVE "SOLUTION" TO PROBLEMS OF MATH AND SCIENCE ACHIEVEMENT CAN FEED INTO THE DESTRUCTIVE REDUCTION OF SCIENCE TEACHING INTO COMPILATIONS OF "TERMS" AND FORMULAS THAT ARE ADDRESSED MORE TO THE TEST THAN UNDERSTANDING OR EXCITEMENT.

DESPITE (OR BECAUSE OF) THE PROBLEMS OF MANY FORMS OF STANDARDIZED TESTING, HOWEVER, ONE OF OUR GREATEST NEEDS WILL BE TO COME UP MORE MEANINGFUL FORMS OF ASSESSMENT OF OUR RESULTS.

IF, AS I'VE INDICATED, WE NEED TOTAL COMMUNITY COMMITMENT TO SUCCESS, WE ARE GOING TO HAVE TO SHOW BENEFITS THAT CAN BE CLEARLY STATED AND EASILY SEEN. STANDARD ASSESSMENT APPROACHES HAVE BEEN HISTORICALLY ABOUT AS STERILE AS THE CONVENTIONAL WAYS OF TEACHING. WE NEED TO GO FAR BEYOND REPORTING ON NUMBERS OF WORKSHOPS, ATTENDEES, ORDINARY TEST SCORES, ETC. INSTEAD, WE MUST SOMEHOW FIND A WAY TO TELL IF OUR STUDENTS ARE FINDING MATH AND SCIENCE MORE EXCITING, FINDING OUT IF WE ARE REACHING STUDENTS WHO HAVE NOT BEEN CONSIDERING MATH AND SCIENCE AS PART OF THEIR NATURAL STRENGTHS AND PATHWAYS, AND FINDING OUT IF OUR STUDENTS ARE INCREASING THEIR UNDERSTANDING OF MATH AND SCIENCE SO THAT THEY HAVE TOOLS FOR THEIR FUTURE EDUCATION AND LIVES, NOT JUST STANDARD ANSWERS TO STANDARD QUESTIONS. WE MUST ALSO FIND OUT IF THE SSI STATES HAVE SUCCEEDED IN THE CRITICAL PROBLEM OF BREAKING DOWN THE BARRIERS TO COMMUNICATION AND PARTNERSHIP AMONG ALL OF THE CONSTITUENCIES IDEALLY INVOLVED IN SCIENCE AND MATH EDUCATION. IN SOME CASES, ORGANIZING AN SSI PROPOSAL HAS SERVED TO START BREAKING THOSE BARRIERS, BUT WE WILL HAVE TO WORK HARD TO KEEP THEM COMING DOWN.

4. WHAT WILL IT TAKE TO SUCCEED?

MOST IMPORTANT WILL BE STRONG LEADERSHIP AT TOP STATE POLITICAL LEVELS, ESPECIALLY THE GOVERNOR'S OFFICE, IN EACH SSI STATE. THE EDUCATION PERFORMERS, THEIR GOVERNING BODIES, AND THE SUPPORT STRUCTURE FOR THE SCHOOLS CONSTITUTE AN EXTREMELY COMPLEX, DIVERSE, AND NON-CENTRALIZED ARRAY OF INTERESTS. TO

SUCCESSFULLY HARNESS THE ENERGY OF THIS SYSTEM, AND KEEP IT MOVING COHERENTLY, THE SSI GOVERNORS MUST BE WILLING TO COMMIT THEIR FULL POLITICAL POWER, AND MAKE THE SYSTEMIC SCIENCE AND MATH EDUCATION REFORM THEME A PERSONAL PRIORITY.

FOR SUCCESS IN THE EFFORT THIS LEADERSHIP WILL HAVE TO BE TRANSLATED INTO UNPRECEDENTEDLY CLOSE AND COORDINATED WORKING RELATIONS AMONG STATE SUPERINTENDENTS OF INSTRUCTION, REGENTS, LOCAL EDUCATIONAL AUTHORITIES, UNIVERSITIES, INDUSTRY AND COMMUNITY GROUPS. PAST RELATIONSHIPS HAVE OFTEN RANGED FROM OUTRIGHT RIVALRY AND TURF BATTLES TO CONCERTED DISINTEREST IN EACH OTHER. THIS WILL HAVE TO CHANGE DRAMATICALLY. THE VARIOUS PARTIES WILL HAVE TO MOVE INTO JOINT STRATEGIC, LEADERSHIP, THINKING; FAR BEYOND OCCASIONAL JOINT RESPONSES TO FEDERAL MANDATES. IN OHIO WE ARE FORTUNATE TO HAVE THE VICE CHANCELLOR OF THE BOARD OF REGENTS AND THE DIRECTOR OF THE OHIO DEPARTMENT OF EDUCATION AS CO-PROJECT DIRECTORS. THIS UNUSUAL PARTNERSHIP HAS SET A SPECIAL TONE FOR THE STRATEGY OF OUR PROJECT: SUCCESS OR FAILURE OF "DISCOVERY" WILL BE A SUCCESS OR FAILURE OF THE ENTIRE STATE, NOT ONE AGENCY OR FACTION.

PATIENCE WITH THE UNFOLDING OF THIS APPROACH WILL BE NEEDED AT NSF, OMB, IN THE CONGRESS, AND AT STATE AND LOCAL LEVELS. WE ARE NOT JUST IMPLEMENTING A SIMPLE "PROGRAM", BUT INSTEAD ARE ATTEMPTING A MAJOR CULTURAL SHIFT IN THE WAY WE PLAN AND CARRY OUT SCIENCE AND MATHEMATICS EDUCATION. THERE ARE CERTAIN TO BE MISTAKES, SET-BACKS, AND FALSE STARTS. IF IT WEREN'T SO WE COULD BE SURE THE PLANNERS WERE NOT SETTING THEIR SIGHTS HIGH ENOUGH. THE SSI PROGRAM IS A BOLD, TIMELY, AND CREATIVE EXPERIMENT, BUT IF WE

DO NOT ALLOW IT TO DEVELOP AND UNFOLD OVER THE NEXT DECADE WE WILL NEVER KNOW IF THE THEORY OF TAPPING STATE VITALITY IN THE DRIVE TO IMPROVE THE NATIONAL QUALITY OF SCIENCE AND MATH EDUCATION WAS THE RIGHT APPROACH.

THE PATIENCE I AM CALLING FOR DOES NOT IMPLY BENIGN OR ANY OTHER FORM OF NEGLECT FROM NSF OR OTHER NATIONAL BODIES. STRONG OVERSIGHT AND NURTURING WILL BE NEEDED AT NSF AND FROM OTHER SUPPORTIVE GROUPS SUCH AS THE ATIONAL GOVERNORS ASSOCIATION, THE NATIONAL CONFERENCE OF STATE LEGISLATURES, AND NATIONAL SCIENCE AND MATHEMATICS ORGANIZATIONS. NSF NEEDS TO AVOID MANAGEMENT AT A LEVEL OF DETAIL WHICH WOULD RE-ESTABLISH THE STATES IN THE MORE PASSIVE, REACTIVE, AND LESS RESPONSIBLE ROLE. HOWEVER, IT MUST PAY CAREFUL ATTENTION TO MONITORING STATE PROGRESS AGAINST STATE PLANS, TO INSISTING ON REAL OUTCOMES AS OPPOSED TO "ACTIVITY", AND IT MUST EXERT UNPRECEDENTED EFFORTS TO BUILD THE COHESIVENESS OF THE DIVERSE STATE PROGRAMS. OTHER NATIONAL SCIENCE AND MATH EDUCATION BODIES MUST REALIZE THAT ENORMOUS PUBLIC RESOURCES ARE GOING INTO THE SSI PROGRAM, AND THAT WE ARE NOT LIKELY TO SEE ANOTHER SUCH A FLEXIBLE AND CREATIVE OPPORTUNITY FOR SYSTEMS PROGRESS IN THIS DECADE. ALL INTERESTED NATIONAL GROUPS OF EDUCATORS MUST TAKE OWNERSHIP IN THIS PROJECT, AND SEE IT AS A WAY TO FULFILL THEIR OWN GOALS. THERE WILL NOT BE A BETTER VEHICLE SOON.

AFTER FIVE YEARS OF SSI WE SHOULD BEGIN TO HAVE MODELS AND ROADMAPS FOR PATHWAYS TO LIFT U.S. MATH AND SCIENCE INSTRUCTIONS TO NEW LEVELS OF EXCELLENCE AND APPEAL TO STUDENTS. THIS WILL ONLY

OCCUR, HOWEVER, IF NSF, PERHAPS IN COOPERATION WITH NGA, NCSL, AND OTHERS, IS ABLE TO KNIT THE STATE EXPERIENCES AND THE TECHNICAL EXPERTISE OF NATIONAL SCIENCE AND MATH ORGANIZATIONS INTO A WORKING CORE OF LEADERSHIP AND INSTITUTIONALIZED THINKING. NSF HAS PLANNED TO PROVIDE "TECHNICAL ASSISTANCE" TO THE STATES IN THIS EFFORT. THAT MAY BE USEFUL, BUT I WOULD POINT TO THE FACT THAT THERE ARE GOOD CURRICULAR IDEAS AND EXPERTS IN THE STATES, AND LABORATORY MATERIALS SOMETIMES SITTING IN CLOSETS. THE BARRIERS TO IMPROVEMENT ARE OFTEN INSTITUTIONAL, AND NSF MUST WORK WITH THE STATES SO THAT THEY CAN HELP EACH OTHER LEARN TO BREAK THESE BARRIERS.

THIS IS GOING TO TAKE BOTH RESOURCES AND VERY SKILLED NSF PROGRAM MANAGEMENT. IT MUST LEAD AND FACILITATE WITHOUT SAPPING ENERGY OR THE SENSE OF RESPONSIBILITY FROM THE STATES. IT MUST DEMAND PLANNING, ARTICULATION AND EVALUATION OF THEIR PROGRAMS BY THE STATES; THE STATES IN TURN MUST REALIZE HOW IMPORTANT THESE INFRASTRUCTURE AND DOCUMENTATION ACTIVITIES ARE IF SSI IS NOT TO TURN OUT TO BE JUST ANOTHER PASSING EDUCATIONAL FAD.

5. THE OHIO "DISCOVERY" PROJECT AS AN SSI INITIATIVE

THE "DISCOVERY" PROJECT IS AIMED AT EMPOWERING TEACHERS TO ALLOW STUDENTS TO LEARN BY INQUIRY OR DISCOVERY: WORKING IN SMALL GROUPS, THOUGH EXPERIMENTS AND PROBLEMS AIMED AT BUILDING THE ABILITY TO USE SCIENTIFIC REASONING AND PRINCIPLES. THE GOAL IS TO HELP STUDENTS LEARN TO THINK AND REASON, NOT TO FOCUS PRIMARILY ON CONTENT, TERMS, AND MEMORIZED TOOLS.

We are fortunate to have committed leadership of unparalleled strength: Dr. Kenneth Wilson, Nobel Laureate in Physics at Ohio State University, Dr. Jane Butler Kahle, a leading international scholar in science education at Miami University, Dr. Garrison Walters, Vice Chancellor of the Board of Regents and Dr. Nancy Eberhart, Director of the Ohio Department of Education. Our Governor pledged the full state matching role for the life of the project as part of our application.

We have a regionalized structure within Ohio that mirrors the federal approach. There are eight autonomous regions designing their own programs within the over-all "inquiry-based" philosophy. Northeast Ohio, where I am involved in the planning, is the demonstration region. Interestingly, our regionalized structure is already presenting us with the same opportunities for exciting local initiative, and the same problems of knitting together approaches of great diversity, that are facing NSF. We in Ohio will also have to maximize the potential of local initiative, while stimulating and insisting on sufficient inter-project communication and planning to make a long-term coherent impact. Similarly, our project is addressing linkages to other kinds of state efforts, such as the formulation of state-mandated science education standards, and the direction of state science competency testing.

Our Ohio project will focus on training of existing middle school teachers in the inquiry approach, based on the sense that we are currently losing the interest of many of our students in science and mathematics at that grade level. We know especially

IN NORTHEAST OHIO THAT WE MUST REVERSE THIS LOSS OF STUDENT INTEREST AMONG FEMALES AND MINORITIES NOW UNDER-REPRESENTED IN MATH AND SCIENCE. WE HAVE HOPES THAT THE INQUIRY-BASED APPROACH, RAPIDLY IMPLEMENTED THROUGH EXISTING TEACHERS, WILL FACILITATE BROADER STUDENT PARTICIPATION AND INTEREST, AS IT ALLOWS RECOGNITION AND REINFORCEMENT OF A GREATER VARIETY OF LEARNING STYLES AND APPROACHES THAN HAVE MANY CONVENTIONAL METHODS OF THE PAST. TWO EXAMPLES OF OUR PROJECT LEADERS' THINKING ON THIS APPROACH ARE ATTACHED.

IN SIMPLE TERMS, INQUIRY-BASED LEARNING IS USUALLY FUN, AS WELL AS STIMULATING. I'VE ALSO ATTACHED A SIMPLE EXAMPLE LESSON ON FOSSIL EVOLUTION WHICH USES JUST A BAG OF NAILS AND FASTENERS FOR SUPPORT. YOU OR STAFF MAY WANT TO PURSUE THIS LESSON AMONG YOURSELVES AND SEE WHERE YOU COME OUT.

THE OHIO PROJECT WILL PROPAGATE ITS APPROACH THROUGH THE CONCEPT OF TEACHER-LEADERS WHO WILL BE INTENSIVELY TRAINED IN SUMMER SESSIONS AND REINFORCING FOLLOW-UP NETWORKS, AND THEN WORK WITHIN THEIR DISTRICTS TO TRAIN COLLEAGUE TEACHERS. IT WILL ALSO INTRODUCE THE MORE RADICAL CONCEPT OF SCIENTIST AND MATHEMATICIAN-EDUCATORS, UNIVERSITY-BASED SCIENTISTS AND MATHEMATICIANS UP-TO-DATE IN THEIR FIELDS, BUT WHOSE SPECIAL CAREER FOCUS IS ON TEACHING AND RESEARCH IN PRE-COLLEGE EDUCATION, NOT DISCOVERING NEW SCIENTIFIC OR MATHEMATICS KNOWLEDGE. WE REALIZE ALSO THAT FOR LONG-RANGE CHANGE WE MUST TAKE THE NEW IDEAS INTO PRE-SERVICE TRAINING OF NEW TEACHERS. THAT IS ONE OF THE MANY CHALLENGES OF CONVERTING THE NEAR-TERM PROJECT INTO LONG-TERM SYSTEMIC CHANGE.

THE NORTHEAST OHIO PROJECT IS INDEED BUILDING ITSELF AS A TOTAL COMMUNITY PROJECT, WITH CITY AND SUBURBAN TEACHERS, PRE-COLLEGE EDUCATION ADMINISTRATORS, UNIVERSITIES, MAJOR FOUNDATIONS, AND INDUSTRY LEADERS ALL INVOLVED IN THE PLANNING. THE GROUP HAS ALSO TAKEN UPON ITSELF THE CHALLENGE OF BUILDING THE LONG-TERM, SYSTEMIC NATURE OF THE CHANGES, BY BEGINNING NOW TO DISCUSS AND PLAN THE MAINTENANCE OF THE PROGRESS ACHIEVED BEYOND THE NSF SUPPORT.

IT IS PERHAPS WORTH EMPHASIZING WHAT OUR "DISCOVERY" PROJECT IS NOT: IT IS NOT AIMED AT INCREASING THE AMOUNT OF CONTENT, FACTS, OR TERMS CONVEYED TO STUDENTS. IT IS NOT AIMED AT ENHANCING THEIR AVERAGE SCORES ON THE COMMONLY USED STANDARDIZED TESTS SO MUCH IN THE PRESS. IT IS AIMED AT MAKING SCIENCE AND MATHEMATICS EXCITING TO STUDENTS WITH MANY BACKGROUNDS AND LEARNING STYLES, TO ENABLE THEM TO BE ABLE TO UNDERSTAND AND USE SCIENTIFIC PRINCIPLES INFLUENCING EITHER THEIR PROFESSIONAL SCIENCE OR NON-SCIENCE CAREERS AND DAILY LIVES.

I HOPE OUR EXPERIENCES AND THOUGHTS WILL BE USEFUL TO YOU IN YOUR OVERSIGHT OF THIS PROGRAM IN COMING YEARS. AS I HAVE SAID, IT IS NOVEL AND EXPERIMENTAL, AND I URGE THE COMMITTEE TO CHECK IN ON IT FREQUENTLY AS IT EVOLVES. YOUR INTEREST WILL HELP NSF AND ALL OF US INVOLVED KEEP AT THE PEAK OF OUR COMMITMENT TO ACCOUNTABILITY AND SUCCESS.

I WOULD BE PLEASED TO ANSWER ANY QUESTIONS YOU MIGHT HAVE.

Project Discovery: Goals & Objectives

- Enhance teachers' knowledge of mathematics and science.
- Improve teachers' skills in working with diverse learners.
- Establish a core of leading mathematicians, scientists, and educators in centers across the state.
- Enhance teaching and learning by inquiry at all academic levels.
- Include technology in teaching and learning in mathematics and science.
- Introduce new approaches to evaluation and assessment for inquiry-based instruction.
- Increase the scientific and mathematical literacy for all Ohio citizens.

Project Discovery is an *active* model that builds upon decades of experimentation and success with inquiry teaching and provides a foundation for sustained professional development of mathematics and science teachers to bring substantive changes in instruction in our schools and to generate long-term educational reform.

Principal Investigators:

Dr. Jane Butler Kahle
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Columbus, Ohio 43210

Drs. Wilson and Kahle bring a wealth of knowledge of science, mathematics and education to this initiative. Professor Wilson, a Nobel laureate in Physics and Youngberg Professor at The Ohio State University, brings the credentials of one who has been eminently successful on the frontiers of science. Professor Kahle, Condit Professor of Science Education and international scholar in science education, provides both research knowledge and an exceptional record of success in increasing the participation of women and minorities in science.

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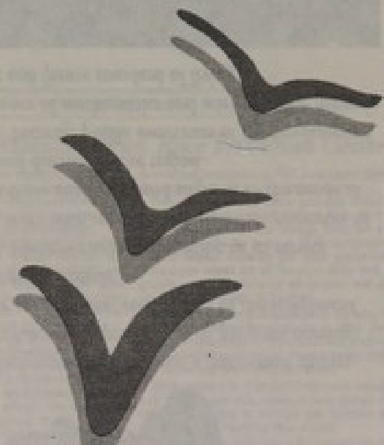

Introducing
The Ohio
Mathematics/Science
Project

Discovery

A National Science Foundation
Statewide Systemic Initiative

Introduction

The National Science Foundation, through its Statewide Systemic Initiative Program, is sponsoring projects that will improve science, mathematics and engineering education from kindergarten through post-secondary education. The objective is to create long-term systemic reform through partnerships of teachers, school systems, parents, institutions of higher education, community leaders as well as representatives of business and industry, foundations, and national, state and regional organizations.

Ohio's Mathematics/Science Project Discovery will use NSF and state funds to improve the quality of the teaching and learning of mathematics and science through research-based, long-term professional development for practicing teachers. As a first step in systemic reform, the project creates a process for sustained professional development of middle school and junior high school mathematics and science teachers and an action plan to increase public understanding of the critical importance of mathematics and science education for Ohio's economic future.

Project Discovery's professional development program includes:

- solid grounding in the content areas of mathematics, life, physical and earth sciences;
- understanding and use of inquiry-based instruction;
- experience with research strategies that assess changes in student learning;
- sustained professional development through regional collaborations of parents, teachers, school systems, college/university faculty, business and industry leaders and community leaders.

Program Structure

The objectives of **Project Discovery** will be accomplished through tiers of professional development, initially at the eight Discovery Regions shown here and the two Host Sites, The Ohio State University and Miami University.

Scientist/educators who have extensive content knowledge, and teacher-leaders, who are exemplary classroom teachers, will form teams for summer professional development activities at the Host Sites. They will be involved in sustained interaction through monthly meetings during the academic year.

After the initial year of professional preparation, the teams will return to their Discovery Region to promote professional development activities in mathematics, science, content-specific pedagogy and technology for other teachers. Team members will work with representatives of the schools, state agencies, the private sector and the community to initiate systemic change in local school systems. Team leaders will also write proposals to secure local financial support for long-term regional initiatives. A state-level Steering Committee will review plans for regional activities, while regional boards will review proposals for local activities.

Each region will be given a three-point charge:

1. Address a specific area of program development or research that contributes to the fulfillment of a statewide agenda.

2. Identify challenges specific to its service region, work with regional and statewide resources to address those challenges and respond to the needs of the school districts in the region.

3. Increase public awareness of the fundamental importance of mathematics and science to the nation's current and future standard of living.

Call To Collaboration

Interested teachers, parents, school systems, institutions of higher education, community leaders, representatives of business and industry, and state and regional resource organizations are invited to form a collaborative partnership to address the goals and objectives of **Project Discovery**. Planning funds are available to Regional Coalitions upon evidence of collaboration and an agenda of action within a region. Interested persons are invited to contact the **Project Discovery** office at the Ohio Board of Regents for additional information.

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In Ohio, Oasis of Integration

A Suburb's Candid, Fruitful Preoccupation With Race

By Isabel Wilkerson
New York Times Service

SHAKER HEIGHTS, Ohio — For 30 years Shaker Heights, a suburban forest of Old World estates just east of Cleveland, has made racial integration something of a crusade. It has tried to hold the races together even as they appear alienated outside its borders.

The city has found that integration is not only difficult to begin but also hard to maintain. If it is to occur at all, residents say, it requires prodding and pampering and a kind of eternal vigilance and preoccupation with race. The city goes so far as to provide financial incentives to those who move into neighborhoods dominated by the other race.

In all the rituals and routines of daily life, it seems, Shaker Heights puts race front and center. The idea is that if left to their own devices, people will resegregate, so the city does not leave them to their own devices. Instead it treats integration as if it were a patient on life support: No one dares pull the plug for fear it will not survive.

And so while most Americans bristle when the topic turns to racial tension, here people look you in the eye and relish the chance to talk about it.

It is in the public schools, which are considered among the most rigorous in the country, that Shaker Heights's race consciousness is perhaps most on display.

Sixth graders are required to take sensitivity training, where they learn about such things as racial polarization and the dynamics of prejudice. An elective course on slavery and the Holocaust, called Oppression, is one of the best attended at the high school.

Race and questions of fairness and balance figure into the smallest decisions, from recruitment to the field hockey team to how many blacks are pictured in a yearbook layout.

There is open fretting about why there are not more blacks on the soccer team or more whites running track. There is pride in the racial symmetry of the chess club and the a capella choir. And among city officials, there is careful attention to the turnout at public events.

"When someone comes back from a block party, we want to know how many people were there, how many blacks and how many whites," said Donald DeMarco, the city's director of community services. "We count. We're aware. We don't pretend not to notice."

Still, for all the effort, there are still black sections and white sections here. Only three of the city's nine neighborhoods are truly racially mixed, with a black population close to the 30 percent level that characterizes Shaker Heights in general. Three are at least 90 percent white and are so expensive that they are likely to remain so for some time. Three are 50 percent or more black, and the city is willing to pay whites to move there.

> **Shaker Heights does not leave people to their own devices.**

With racial tensions erupting in places as disparate as Brooklyn, New York, and Dubuque, Iowa, and the growing use of appeals to racial fears in mainstream politics, determinedly integrated communities like Shaker Heights,

See RACE, Page 3

RACE: *In All the Rituals and Routines of Daily Life, a Town East of Cleveland Puts Race Front and Center*

(Continued from page 1)

Oak Park in Illinois and a half-dozen others stand as oases that, while far from racial utopias, seem well ahead of the rest of the country.

"They are islands in a sea of racism," said Thomas F. Pettigrew, an expert on integration who is a professor of social psychology at both the University of California, Santa Cruz, and the University of Amsterdam. "That they work at all is what is amazing. It is much harder to pull it off when the rest of the country is going in the opposite direction."

Years ago a white Chicago alderman, fearing the arrival of blacks in his neighborhood, defined integration as the time between when the first black person moves in and the last white person moves out. By that definition, many U.S. communities have suffered a brief period of "integration," bitter for the new arrivals and the old-timers alike.

Shaker Heights has followed a different course. It is an elegant suburb with lakes, a country club and architecture that ranges from artful two-flats disguised as single-family Tudors to estates with pools and tennis courts. The community of 30,831 is home to lawyers, bankers and corporate executives. The median family income was $55,747 in 1987.

The first blacks, mostly doctors and dentists and their families, began moving in in the late 1950s after restrictive housing covenants were declared illegal by the Supreme Court. Shaker Heights was a natural landing place for blacks looking for their dream houses. It borders Cleveland's East Side, where most of the city's blacks are concentrated; it is only a train stop or two from the old neighborhood, has snob appeal and a highly regarded school system.

Whites in Shaker Heights decided to make the best of it. They tried to figure out a way to prevent a white exodus, to maintain property values and to a create a stable, multiracial community. They tried to anticipate white racial fears and defuse them. One of the first steps was prohibiting, in 1964, the display of for-sale signs on front lawns to stave off panic selling.

The doomsday predictions of declining schools and property values have not materialized. Increases in property values have outpaced those in the rest of Cuyahoga County, and school test scores exceed national averages, just as they did before the first black family moved in.

Shaker Heights manages its racial housing patterns the way companies manage inventory. It tries to stimulate demand where demand is weakest and discourage demand for what is scarce. Because integration is historically a harder sell to whites than to blacks, that essentially means keeping white families in Shaker Heights.

"Unfortunately, you can't leave it to market forces," said Stephen J. Alfred, the mayor of Shaker Heights and an early leader in the integration plan. "Whites can move anywhere they can afford. The number of whites who want to move into a mostly black neighborhood is small. You have to go out and find them. Meanwhile you've got co-workers and grandparents saying, 'Don't do it.'"

To get people to swim upstream, the city rewards blacks and whites who move where the city wants them. It is a much-debated form of social engineering that for five years has given low-cost loans to members of either group if they move into neighborhoods where they are underrepresented.

Whites get help with their mortgages if they move into a neighborhood that is 50 percent or more black. Blacks get help if they move into a neighborhood that is 90 percent or more white. The loans are typically $3,000 to $6,000, based on how segregated the neighborhood is, and are paid in a lump sum toward the down payment or in monthly installments toward the house note. The city grants about 25 loans a year from a $390,000 fund financed by private donations.

Economics limits the program's reach. The white neighborhoods are the leafy mansion districts surrounding the country club, where few blacks can afford to move anyway. The neighborhoods where whites are encouraged to move have the city's most affordable housing, the smaller Tudors and Georgians. So 90 percent of the loans go to whites.

But because many blacks want to move to Shaker Heights, the city tries to direct them elsewhere when it can. Along with several adjacent suburbs that have significant black populations, it funnels similar loans to blacks if they agree, and are financially able, to move to a virtually all-white suburb. The designated white suburbs, known collectively as the Hillcrest area, neither contribute to the loan program nor advocate it.

"In terms of creativity and ingenuity, it represents a sharp break from past thinking," said Marc Zegans, research director for Innovations in State and Local Government, a program of the Kennedy School of Government and the Ford Foundation, which cited Shaker Heights in 1988 for its integration initiative.

"Integration needs to be managed," he said, "until we have a society that accepts it as the norm."

Because many residents live in neighborhoods that are dominated by one race or the other, Shaker Heights is at its most integrated when the children go to school.

Slightly more than half the students are black, and some schools had become predominantly black or white until the city consolidated the system and redrew school boundaries in 1987. Less than 3 percent of the students are Asian, Hispanic or Indian.

Now each elementary school goes only to the fourth grade and takes in enough children from the nearest black neighborhoods and enough from the nearest white neighborhoods to get a 50-50 enrollment. The balance issue is moot for the other grades because there is one school for all the city's fifth- and sixth-graders, a middle school for all seventh- and eighth-graders and the single high school.

But even though the students are in the same building, the high school in particular is more like two schools in one. Advanced placement and honors classes are overwhelmingly white. Regular college preparatory classes are overwhelmingly black.

White students in Yale and Dartmouth sweatshirts walk the hallways with whites to their honors classes and black students in Howard and Spelman sweatshirts walk with blacks to their classes.

In the cafeteria, with only a few exceptions, blacks sit with blacks and whites with whites. They are generally segregated by sex as well. There is no pushing, no shoving, rarely a cross word or rolling of eyes, just peaceful, mutual, voluntary segregation.

"You don't have a choice in the classroom," said Kirk Nims, a black sophomore. "You eat lunch with who your buddies are."

The students say they have nothing against any other group and have friends of the other race whom they have known since elementary school.

"There's a lot of pressure," said Bill Koenig, a white freshman. "If you sit with blacks, your friends would say, 'Why are you hanging out with those other people?' I know it's not good. But people tend to go where they're comfortable."

National Science Foundation

NEWS

Alan Levitt
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EMBARGOED UNTIL:
10 a.m. (EDT) May 14
NSF PR 91-46

NATIONAL SCIENCE FOUNDATION FUNDS DRAMATIC REFORMS IN SCIENCE & MATH EDUCATION

In the federal government's most far-reaching effort in science and math education since the President's education summit with the Governors, 10 states have been selected as the first to receive funds for systemwide reform of their math and science education programs from kindergarten through the undergraduate level, Dr. Walter Massey, Director of the National Science Foundation (NSF) announced today.

"This program is different because it is comprehensive and has a very high degree of participation from the key leaders and institutions involved in education in these states, from Governors to the community leaders and parents," Massey said. "Past reform efforts in science and math education have focused on a part of the education system. We are no longer looking solely at parts of the system, but at the whole system of education. This public-private partnership will assist the nation in moving forward the President's education goals for the year 2000."

-more-

"NSF's program is the first effort I am aware of with a comprehensive, positive and organized approach to assisting the states with science and math education reform, " said South Carolina Governor Carroll A. Campbell, Jr. who, with Colorado Governor Roy Romer, is a lead Governor on Education for the National Governors' Association. "The program will certainly expedite the national education goals for science and math."

"I commend NSF for selecting states that are as diverse in size, resources, and population as they are in the methods they will use to attack the problem of systematic science and math education reform," said Romer. "They represent a broad variety of models for the rest of the country as governors strive to meet the national education goals."

The awards, totalling $75 million for up to five years, will be matched by states and are the first in NSF's Statewide Systemic Initiative (SSI) program. There was intense competition for the awards, which are intended to act as a catalyst for comprehensive changes in science and math education. Thirty states spent more than a year preparing proposals which were reviewed by panels of experts who also made visits to the finalist states.

Proposals from the ten states selected for funding--Florida, Montana, Nebraska, North Carolina, Ohio, Rhode Island, Louisiana, Delaware, South Dakota, and Connecticut--demonstrated a rich variety of integrated and well-coordinated plans to address major components of the states' educational systems.

"The program brings together Governors, state and local education leaders, businesses, parents, and other community leaders," Massey said. "By working together, this partnership can make a real difference."

Each project also will involve a partnership of executive, legislative, educational, business, and public leadership. This initiative has already served as the catalyst for individuals and organizations within each state to begin to work more closely together to improve science and mathematics education.

Specific examples of SSI-funded projects include: Florida will develop a thematic approach to elementary science and mathematics based on the environment. Connecticut will target poor urban and rural districts through state and local cooperative efforts coordinated by a state chartered Academy of Mathematics, Science, and Technology. And Nebraska plans to improve its science and mathematics education by featuring "distance learning," an opportunity for students in a rural

-more-

state to overcome their isolation by participating in lessons presented through the state's interactive telecommunications system.

Unlike most NSF grants, Statewide Systemic Initiative awards are made as part of a cooperative agreement between NSF and each state, allowing NSF to provide substantial technical and management advice in the development and implementation of the projects.

NSF funding to these states will be phased out during the agreed-upon project term. It is planned that significant systemic changes would be supported through long-term fiscal commitments from state legislatures and other sources, public and private, to assure permanence of the reforms begun in this program.

-end-

Note to television assignment editors: A satellite feed consisting of soundbites of Dr. Massey and Dr. Luther Williams, NSF Assistant Director for Education and Human Resources, will be transmitted between 2 p.m. and 2:30 p.m. (EDT). Satellite coordinates: C-Band, Westar 5/Channel 4, audio 6.2 and 6.8.

(5/14/91)

THE PLAIN DEALER, WEDNESDAY, AUGUST 28, 1991

Ohio aims to boost schooling

By JANE BUTLER KAHLE and KENNETH G. WILSON

Scientific illiteracy is a national crisis.

If the United States is to remain competitive economically in an increasingly technological world, we cannot continue to permit our youngsters to cringe at mathematics and avoid science.

Consider these facts:

■ The track record for U.S. students on math-science achievement tests is abysmal. In a recent biology test taken by high school seniors in 14 countries, American students ranked 14th.

■ College enrollments in science courses are lagging. Of high school students who enter college intent on pursuing careers in science, as many as 60% change their minds before graduation.

■ More than half (54%) of engineering doctorates awarded by U.S. universities in 1988 went to non-U.S. citizens.

■ Our scientists and engineers are overwhelmingly white and male, but even if every white male child now in school decided to become a scientist, engineer or mathematician, there would be a shortage in the technical labor pool by the year 2020.

Report after report has documented our failure to make science come alive for students. Last year, the National Research Council warned that biology, the first science presented to most students, is taught so poorly that it "seems designed to snuff out interest" in all science education at an early age.

But the situation is not hopeless.

Research on how children learn science and mathematics has demonstrated the need for major changes in the classroom. We know what needs to be done. Now it is time for action. And Ohio youngsters will be among the first to benefit from the changes.

President Bush has set a new national goal of making U.S. students first in the world again in science and mathematics. As part of the president's plan, 10 states — including Ohio — have been awarded $75 million by the National Science Foundation (NSF) to develop comprehensive mathematics and science programs.

The NSF commitment to Ohio's Discovery Project is $10 million over the next five years, with the state expected to provide matching funds. This massive allocation of tax dollars will finance a revolutionary change in the way science and mathematics are taught in the state's classrooms.

The emphasis on memorization of scientific facts will be replaced by the excitement of exploration. Teachers will no longer be "tellers of facts" but *guides* as students discover important principles of science and mathematics by answering carefully structured questions.

For example, in the past, a teacher presenting a lesson on electricity to a group of fourth graders would typically read to them about circuits. By contrast, teachers using the discovery method will bring in wires and flashlight bulbs and begin the unit by having the children build a

Research in the Cincinnati-area Mount Healthy school district, where all fourth and fifth grade teachers have been trained in this inquiry-method of teaching science, has demonstrated its effectiveness. There was a 30% jump in attitudes toward science after students spent only one week doing hands-on electricity experiments.

Project Discovery's first step will be to establish centers at Miami University and Ohio State University where teachers of science and mathematics from throughout the state will come to learn the inquiry method.

Eventually, 10 regional centers will be opened across Ohio, starting in Cleveland, to link scientists and educators and provide resources to classroom teachers. These centers will ensure that every classroom teacher in Ohio has state-of-the-art advice and assistance.

Cleveland-area students will be among the first to benefit because educators from throughout Cuyahoga County are involved in creating a prototype center for dissemination of the latest and best methods to teach science and mathematics.

Under the Discovery Project, middle-school teachers will learn a method for teaching physics using a model developed over a 20-year period at the University of Washington in Seattle. Mathematics, particularly preparing for algebra, will receive equal attention. Other science courses will be developed later.

Ultimately, the goal of the Mathematics/Science Discovery Project is to improve the teaching of science and mathematics in every Ohio classroom. Initially, it is aimed at improving the way science and math are taught to middle school students, because it is at this critical period that many young people permanently lose their interest in science.

We must stop accepting science and mathematics as filters that weed out the unmotivated and the less able.

We must reform our centuries-old instructional style. It is time we provide true equality in the opportunity to learn. That means ensuring that all students get the benefit of proven new methods of instruction.

It's not that we expect every Ohio youngster to become a Ph.D. scientist. But it's better to be educating students who will have the option of making $12 an hour as technicians in a laboratory involved in lowering the cholesterol in meat than $4.25 an hour flipping hamburgers.

Kahle, Condit professor of science education at Miami University, directed the Mount Healthy research. Wilson, Youngberg professor of physics at Ohio State University, is a Nobel-Prize winning physicist. They, in partnership with the Ohio Board of Regents, recently received a $10 million grant from the National Science Foundation to improve science and mathematics education in Ohio's schools.

OPINION

INTRODUCTORY PHYSICS FOR TEACHERS

Kenneth G. Wilson

I can (I think) summarize my basic premise here with an analogy. A university foreign language department's beginning course in French—call it French I—is for students who have no previous experience with the language. This course starts out with very basic vocabulary such as the verb *être*, meaning "to be." In contrast, most physics departments at research universities do not, as far as I know, offer an equivalent Physics I course for students with no previous background in physics. This deficiency hurts many students, because only about 20% of all US high school students take high school physics, and there are few other opportunities for students to acquire a physics background prior to college. The absence of a Physics I course is especially devastating for those intending to be teachers because many of them will need to be able to teach the material they would have learned in such a course. Yet there is no organized route for these future teachers to learn Physics I well enough to be able to teach it, nor can they learn the methodologies for teaching it effectively.

The physics departments I have been associated with in research universities do not reward special efforts by professors to help teachers. Instead, the expectation is that any prospective or practicing K-12 teacher who plans to teach physics will take standard university physics courses. This means they do not study Physics I or learn how to teach it.

A number of physicists around the country have many years of experience working with teachers. Those known to me have found that the standard university physics courses provide inadequate preparation for most teachers.[1] There are excellent physics teachers who have learned largely by themselves what to teach and how to teach effectively, but there are not enough self-taught teachers to fill the current need for physics instruction in US schools.

The subject matter appropriate for a Physics I course has been known at least since the 1960s, when several NSF-sponsored science curriculums for elementary schools were developed.[2] These curriculums cover standard physics topics such as motion, electricity, heat, optics and bulk properties of matter. However, these topics are presented at a level that does not require algebra, let alone calculus. Instead of focusing on extensive problem solving as college-level courses do, these curriculums focus on simple, inexpensive experiments that illustrate physical models of everyday phenomena. For example, one of the most famous units is called "batteries and bulbs." To begin this unit, children are presented with a battery, a light bulb and a wire, and are asked to find out how to make the bulb light. What is non-trivial about this experiment is that students with no previous physics experience often have concluded by themselves that electricity comes out of a wall plug or a battery and is used up in light bulbs or appliances. So they expect the light bulb to light if they simply attach one end of the wire to the battery and the other end to the light bulb. It takes some time for them to discover that they have to make a closed circuit before the bulb lights. One can, of course, tell the students in advance that they have to make a closed circuit, but to do so spoils the learning and excitement students develop when they make the discovery for themselves, contrary to their intuition.

The student's model of electricity is an example of their "misconceptions" of physics, a topic discussed elsewhere in this issue and in other articles and books.[3] Students' false conclusions are often sensible inferences based on evidence insufficient to justify a more complex conclusion.

The absence in research universities of appropriate science curriculums for teachers has been a problem for a long time. However, an even more challenging problem needs to be solved. The current wave of education reform has led to a new set of national goals for education, one of which is that science will be taught effectively at all grade levels (starting well before fourth grade) rather than in single-year high school courses. It is important that physics be a key part of the reworked science curriculums because basic physics is a prerequisite for understanding other scientific areas: Can one understand atoms without first understanding electricity? Can one understand weather without first grasping the concept of air pressure?

I have joined an effort in Ohio called, for short, the Discovery Project. One of its aims is to offer to practicing teachers in Ohio—starting with middle school teachers—Physics I and sister courses in mathematics and other sciences at 10 regional centers to be established across the state. The Discovery Project is one of 10 "Statewide Systemic Initiatives in Science and Mathematics Education" recently funded by the National Science Foundation, and it has matching funds from the State of Ohio. The project is organized through the Ohio Board of Regents with the cooperation of the Ohio Board of Education; I am a co-principal investigator with Jane Butler Kahle (professor of biology education at Miami University of Ohio) and E. Garrison Walters (vice-chancellor of the Board of Regents).

In helping to prepare Ohio's proposal to NSF, I have spent more than 50% of my time over the last year learning about problems of US education from people with 20 or more years of experience trying to cope with and understand these problems. I report what I have learned specifically regarding the need for Physics I.

First, teachers in elementary and middle school grades are usually assumed to be generalists, expected to be able to handle many subjects. I

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encountered a typical example of this expectation, an art teacher who was told: "Our science teacher just left. You start tomorrow." Hence, to assure continuing availability of physics instruction to all students, most of the over one million teachers in US schools—not just a small subset of them—will need access to Physics I. The challenge, then, to the physics community is to provide Physics I to a much larger population of teachers than, for example, just high-school physics teachers.

The second thing I have learned is that I do not have to design a Physics I course from scratch. Instead, my own efforts are based on an existing course from the University of Washington. There is a version of this course that is specifically designed to serve elementary and middle school teachers (both prospective and practicing); it includes the relevant subject matter and is taught in a way that explicitly models the teaching methodology that teachers are encouraged to use in their own classrooms. The course was established by Arnold Arons[4] after he came to the University of Washington physics department in 1968, and has been greatly enhanced by Lillian McDermott. She and her colleagues in the Physics Education Group at the University of Washington have developed for their course a set of laboratory-based instructional modules with accompanying instructor's guides, collectively entitled *Physics by Inquiry*.[5] The text incorporates more than 20 years of experimentation in how to achieve maximum effectiveness with the intended audience. The modules draw heavily on the precollege curriculums developed with NSF support.[2,6] As they work through the many experiments and exercises contained in the modules, the students are guided by the sequences of carefully structured questions designed to lead them to an understanding of the physics involved. *Physics by Inquiry* will be used in the Ohio program, saving us many years of effort. Last year Suzanne Lea, who for many years has given this course at the University of North Carolina, Greensboro, offered a similar course as a visiting faculty member at the Ohio State University.

Teachers and instructional staff work together on an activity involving simple dc motors. The teachers are participants in the 1991 summer program for practicing teachers conducted by the Physics Education Group at the University of Washington, Seattle.

In its present state, *Physics by Inquiry* has some shortcomings for implementation on a statewide level in the Ohio program. The most severe problem that needs to be addressed is the heavy load placed on the course's staff. The demands on staff time are heavy because the course will not be successful unless faculty and staff refrain from telling the students what the experiments prove. Instead they should ask questions, in addition to those in the modules, to help students find their own answers. When students are not provided with answers, they tend to ask many questions. The courses for teachers at the University of Washington have the benefit of a large staff with a strong background in physics and the teaching of physics.

Physics by Inquiry has been successfully taught with some less experienced staff than is available at Washington. The success of the course in these instances can be attributed to the use of the available modules by capable instructors who have been able to train inexperienced teaching assistants. The way in which the modules are structured plays a critical role. The students can refer to them for guidance instead of asking the staff which initial steps they should take to perform the experiment. In addition, the modules raise the questions that help the students begin to develop an understanding of the underlying principles. It is much easier for an instructor to prepare teaching assistants to handle follow-up discussions than to prepare them to define the experiments and to decide on the key questions they should ask students.

The development of effective techniques for teaching the course with a small staff and for training that staff is an important task that needs further attention. Past experience has shown that there should be no more than 12 students per staff member. In fact, Lea, in trying to teach the course with 20 students per staff member, encountered serious difficulties: Some students were considerably slowed down waiting for attention from a staff member, while other students who charged ahead without waiting to talk to staff never overcame many of their misconceptions.

The third thing I have learned is that the development of *Physics by Inquiry* required the long-term, full-time effort of a physics research group focused on education.[7] And I expect the scaling-up process will require more of the same. Research was needed to design the experiments and question sequences so that the modules would be successful with students the designer had never met. In preparing to build their modules, the Washington group conducted intensive interviews with students about physics subjects to determine in detail their specific misconceptions, the goal being to design precisely experiments that resolve these misconceptions. Examples of the impact of this research on curriculum development can be found in the module on electricity in *Physics by Inquiry*. "Electric Circuits" has a whole set of experiments based on batteries and bulbs, of the type I described earlier, that help students to understand the need to define electric current, voltage and energy as three distinct concepts with distinct phenomenology.

For the scaling-up process to be successful, there are two major problems to be resolved. One is to build permanent connections with teachers

OPINION

who study *Physics by Inquiry* so that they get the moral support they need to teach physics successfully to often unenthusiastic students in school systems with limited budgets for science. The teachers would also receive the technical support they require in answering student questions that go beyond their own knowledge, and the professional support they need as they try to expand their understanding of physics beyond their formal coursework. A major goal of Ohio's Discovery Project is to establish such a support structure through the regional centers.

The second problem is to make *Physics by Inquiry* less costly to teach. I see three opportunities for solving this problem. One is to save staff time by simply continuing to develop written materials that explain the instructional goals of both the modules as a whole and each experiment in particular. The Physics Education Group at the University of Washington is in the process of producing instructor's guides, but work remains to be done. For some of the experiments and exercises the guides do not provide enough information for an untrained staff. In those cases Lea has found that she must devote valuable time during weekly staff meetings to giving detailed explanations.

A second opportunity for addressing the problem of cost effectiveness is to invite students who have taken the course previously to serve as peer instructors. The Washington group has included peer instructors on the staff of their courses. This approach appears to be effective, but no systematic testing has been done to determine by how much the presence of peer instructors can increase the ratio of students to professional teaching staff. A third opportunity is to use computers to provide interactive sessions, thereby easing the staff's workload. Designing interactive sessions that fit in with the existing course is a difficult task, but one worth pursuing, and Lea has already begun an effort in this direction.

Pursuing any of these three opportunities is sufficiently challenging, from my observation, to require the full mental efforts of a number of physicists. Part of the Ohio Discovery Project's plan is to place physicists, along with other scientists and mathematicians, in partnership with highly experienced teachers from Ohio schools, at the regional centers full time. In recognition of these physicists' full-time professional efforts, a new name has been proposed to describe their profession—"physicist-educator." Another part of the Discovery plan is that nominees for the physicist–educator positions will be given a year to learn to teach *Physics by Inquiry*, learning about the myriad problems that teachers face when teaching science in the classroom, about successful methods teachers use to deal with these problems, about the misconception research and more.

I return to my opening observation that research universities typically do not reward special efforts by faculty on behalf of teachers, a situation that can, I believe, be changed, in particular by pursuing the kinds of challenges that have arisen in the Discovery Project and out of an overall goal of reaching millions of teachers nationwide.

The most potent reward a department can grant is promotion to tenure. There has been a long-running controversy over whether teaching excellence should carry equal weight with research excellence in tenure decisions. Having sat through 25 years of tenure meetings, I have come to believe that important safeguards are built into the current emphasis in tenure dossiers on research excellence and that they need to be preserved. The safeguards, namely requirements that the candidate has published original work in competition with peers nationally and internationally and that letters from these peers affirm the high quality of the candidate and his or her work, ensure that tenured faculty will be of consistently high quality. In contrast, the achievements in teaching of most candidates are known only to a few members of their own departments, not nationally, and most candidates are not viewed as being in competition with peers nationally to make original contributions to teaching. It is imperative that physicist–educators approach their work from a scholarly perspective and meet the same standards, including publication and external recognition, as do their colleagues in more traditional research. When physicist–educators meet these standards, their work should be recognized through the traditional academic reward structure.

There are many significant problems in physics education that require the attention of physicists. Providing Physics I for a huge audience is one of these. This challenge has never been met (to my knowledge), and I believe most physicists would agree that it is a challenge as difficult as that of making significant contributions to standard physics research. The work will certainly involve national and international competition to achieve rapid progress in improving physics education, enabling the safeguards of normal tenure decisions to be met.

A small number of physics education research groups are in existence (at, for example, the University of Washington and San Diego State University) that can supply the initial set of peers for outside letters on tenure decisions. Hence, I believe the establishment of more physics education research groups can go forward, with appointments of full-time physicist–educators into tenure-track or tenured faculty positions, and with the safeguards of normal tenure awards in place. I hope that through the Discovery Project, Ohio will be the first state to establish a critical mass of physics education research programs, with programs throughout the state. Nevertheless, I would welcome efforts elsewhere to compete with Ohio's efforts.

* * *

I am grateful to Arnold Arons for 50 years of discussions. I have also learned from education-school faculty, education researchers, teachers, scientists, industrial executives and others working full time on educational reform.

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The Nuts and Bolts of Evolution

A presentation developed by

Carole Goshorn, 1985 Presidential Awardee in Science
Columbus East High School, Columbus, IN

Annual Meeting of the American Association for the Advancement of Science, Feb. 9, 1992

Good teaching centers on actively involving students in their learning. Such is the premise of the laboratory. However, the lab too often becomes a cookbook activity with predictable results. A twist is to introduce an open-ended laboratory which challenges students to develop their own model and defend its predictive power. Such is the example presented below.

Each team (2-3 students) receives a film canister with six to eight different types of fasteners. These represent the geologic fossil record of fasteners as currently known. Their mission is to develop a sequence of probable evolution by identifying changes in fastener traits. The team must work together (discussion and consensus is encouraged) and be able to defend their evolutionary scheme. During a class question and answer session, each team explains their scheme and can be challenged by other groups. Team members should be prepared to defend and explain their decision-making process. Once all have presented, it is announced that a new fossil has just been discovered. Team members must now evaluate how to fit this new discovery into their scheme.

Materials Per Student Team:

1 - 35mm film canister	1 "new" fossil fastener
6 - 8 varied fasteners	overhead transparency & pen

Vital to this activity is team interaction. Each member must contribute to the decision-making process and be able to present their evolutionary tree. Inform students of the importance of voicing differing viewpoints, since evaluation of alternative pathways will strenghthen their final scheme and better prepare them to explain and defend their position to the class. Empasize the fact that this is an open-ended lab (no one right answer), and evaluation is based upon the clarity of the presentation and logic of their scheme. In this way students are challenged to use observation skills, knowledge of evolution and their imagination to develop a logical evolutionary tree. During the final phase the new "fossil" fastener provides a test of the scheme and an opportunity to revise it if necessary. This allows students to assess their model and determine whether modifications are necessary. Rather than verifying expected results, the lab requires students to group problem-solve, create a model, and assess it's predictive power--the same skills vital to any researcher.

Mr. BOUCHER. Thank you.
Dr. Leppert?

STATEMENT OF JOHN D. LEPPERT, DIRECTOR, OFFICE OF SCIENCE EDUCATION IMPROVEMENT, FLORIDA DEPARTMENT OF EDUCATION; AND PRINCIPAL INVESTIGATOR AND PROJECT DIRECTOR FOR THE FLORIDA STATEWIDE SYSTEMIC INITIATIVE

Dr. LEPPERT. Thank you.

Thank you very much for the opportunity to say a few words. But first let me compliment you, Mr. Chairman, and your staff and the staff at NSF for starting a very small and very exciting project.

In the case of Florida, this appropriation has made a very major change. It has reached far beyond the dollars that have been appropriated. You have really provided the catalyst that was needed to allow a State in a budget crisis—and most States are nowadays—to move forward with some developmental monies. During these periods of retrenchment, this is a bright star on the horizon.

In addition to the initiative itself, I would like to indicate that we have attracted significant other dollars to the program.

You have asked if it is working. It is working very, very well in Florida. Many other initiatives have been turned over to our Science Improvement Office for operation. Those include significant Eisenhower dollars, our Regional Centers for Excellence in Math and Science, our Environmental Education Centers, our Summer Science Camp programs, and soon to be the operation of our science fair program within the State will be managed and/or coordinated through our Science Improvement Office.

I would also like to say something about the process in NSF itself. Dr. Wilson had asked me to comment on that. You have created a somewhat new device for distributing dollars. This is not a grant nor is it a contract. It is a cooperative agreement. We like the sound of it. A grant may give us too much freedom. A contract for specific deliverables may be too constraining. This partnership with NSF is applauded.

I would like to say something about other benefits that have derived from it. As the two previous speakers have mentioned, there is an excitement in the air. The terms "Systemic Initiative" bring a lot of people saying, "What's that? What's it all about?" As soon as you explain it to them, they immediately respond favorably.

Our Game and Fish Commission and its instructional programs have come to us with help. The NASA Center at Cape Kennedy has come to us with help. The Governor's Energy Office wants to give us more money. Our water management districts are coming to us with their instructional programs and seeking to coordinate the development of teacher educational programs with ours.

The Division of Parks and Lands has come to us and wants to work with us in developing instructional programs in the field so that we can have more field-based science opportunities, particularly for freshmen and sophomores in the universities and community colleges, as well as in our elementary schools.

I would also like to applaud NSF for seeking to collaborate through our Systemic Initiative Programs other initiatives in the State. I have received numerous phone calls at the request of NSF to ask their proposers on future grants to please coordinate with our office and to make sure that we are being as efficient as possible with NSF funds. So I can, at an early point, steer proposer-writers to filling the gaps that exist in our program. And I think through their efforts in NSF in requiring this, we will find a very efficient use of what are always limited dollars.

Finally, you did ask if there were some barriers to systemic change. Yes. Many opportunities exist out there. But perhaps the largest barrier may be that different Federal agencies and different States may be heading in non-compatible directions.

Pooling together resources that have origins in different Federal agencies and within and among different States may be a large problem. It will be important somehow to ensure—I have used the word "a symbiotic relationship"—among all the major initiatives under way.

I am concerned that the enthusiastic efforts of so many well-intended people may produce needless competition and confusion in the minds of the public, the media, State legislators, producers of instructional materials, which really are exceedingly important in this process, and teacher trainers.

For example, we and Ohio are moving in similar directions, but California and Texas, which are not a part of this program, are undertaking major contracts with textbook publishers to use an approach which is not likely to be compatible with the Ohio and Florida approaches in terms of the pedagogical approach to instructing science.

There are numerous other examples even among States that have sought to understand what the major concepts are in science. For example, we both have what is known as a constructivist view, seeking to teach less deductively, more inductively.

Having agreed on that, many of us, however, have different views as to what the big concepts are in science, and many people are off developing materials that may not be useful across the States.

While this may not be the best forum for discussions regarding a national curriculum, the issues of coordination have recently been raised again by the Carnegie Commission with their recent report, "In the National Interest." To not decide issues of coordination is to decide to continue a number of expensive, disjointed efforts which the Nation today can ill afford.

Specifically, within the Systemic Initiative program, I would urge that future States brought into the effort be required either to fill the gaps cooperatively identified but not yet addressed by the first two groups of funded Systemic Initiative States or be offered the chance to implement initiatives developed by former participants. We are about to have up to 20 Systemic Initiative States. It may not be necessary to have 40 or 50 all going off in alternative directions.

Again, I do applaud your efforts. We have found a great deal of excitement in Florida—and, I know by talking to the other States, in those States—over this initiative, and I urge you to continue it.

[The prepared statement of Dr. Leppert follows:]

Written Testimony of John D. Leppert
Subcommittee on Science
Committee on Science, Space, and Technology
U.S. House of Representatives
February 25, 1992

Chairman Boucher:

Your invitation to describe our experiences as we begin one of the first Statewide Systemic Initiatives is welcome. Hundreds of Floridians are currently involved in our efforts and hundreds more, mostly teachers, will become active participates in redesigning both the content and the approach to learning science concepts in the months ahead. While Florida is the most populated state of the 1991 awardees, with a diverse and rapidly growing student body of 100,000 students annually, we have the benefit of a recently adopted plan for achieving significant reform in mathematics, science, and computer education. The Systemic Initiative award, with its immediate focus on science education at the elementary and college levels, allows us to begin to act on that plan. Given the state budget crisis, we could not have moved this effort forward without your funds.

In response to your multiple areas of inquiry, I would like to record a number of observations and suggestions, from general to specific, which may aid the Committee.

1. First the words "Systemic Initiative." They are great!! People must think about them. The speaker is given a wide array of options to question, relate and listen.

2. Once an audience develops an operational definition of Systemic Initiative they can immediately relate their opinions to it. At first everything fits and systemic reform and the consensus building process can be started more quickly than in most reform movements. We often pair the words "initiative" and "improvement." Our office title is the <u>Office of Science Education Improvement: a Statewide Systemic Initiative</u>. People do not like to be changed, reformed or even trained but they like to initiate improvement. Consideration should be given to changing the word "reform" to "initiative" in more of your budget documents.

3. Implicit in effecting an initiative's direction is the formation of new mind sets. I presume that you or NSF provided for the process called a "cooperative agreement." The approach has helped me! Pressures to allocate funds and staff, select priorities or direct subcontracts could be substantial within a state, especially during these years of financial stringency. By establishing a grant process, too much local freedom sometime results. A contract with predetermined processes and deliverables is usually too constraining for a creative venture. This is just right. I appreciate the flexible partnership implied by a "cooperative agreement."

4. The process of implementation of the new "Systemic Initiative" program did seem to take a long time, both at NSF and in our state, given the extent of the national crisis. I recommend to you the expertise of Dr. Charles Eilber for more on the history and possible solutions to this issue.

5. In Florida, discussions among administrators in the Department of Education are taking place with the intent to consolidate related programs and resources under the direct coordination of the Statewide Systemic Initiative. Programs and resources include the Title II Dwight D. Eisenhower Discretionary funds, Summer Mathematics and Science Camps, Regional Centers of Excellence for Mathematics, Science, and Computer Education, and the Regional Environmental Education Service Projects. Furthermore, all of the competitive post-secondary and much of the pass through public school Eisenhower funds will be directed to generously supplement the NSF program. We believe we now have that critical mass needed to move a program forward.

6. The Statewide Systemic Initiative has given the state a unifying set of goals and objectives which all related programs in the Department of Education, such as the Eisenhower Higher Education Grant Awards, can use as a focus.

7. Inter-Departmental alliances within Florida by science rich agencies such as the Florida Game and Fresh Water Fish Commission, the Governor's Energy Office, the Water Management Districts, and the Florida Division of Parks and Lands, are developing since the award of the Statewide Systemic Initiative.

8. New recommendations put forth by NSF regarding linkages with the Statewide Systemic Initiative have helped to ensure collaboration within the state as new proposals to NSF are being written by districts and colleges.

Perhaps the largest barrier to systemic change may be that different federal agencies and different states may be heading in non-compatible directions. Pooling together resources that have origins in different federal agencies and in different states may be the largest problem. It will be important to ensure a symbiotic relationship among all of the major initiatives underway. I am concerned that both within states and across states the results of so many well intended people may produce needless competition and confusion in the minds of the public, the media, legislators, producers of instructional materials, and teacher trainers. While this may not be the best forum for discussions regarding a national curriculum, the issues of coordination have again been raised by the Carnegie Commission with their recent report, "In the National Interest." To not decide these issues is to decide to continue a number of expensive, disjointed efforts which the nation can ill afford. Specifically within the Systemic Initiative program, I would urge that future states brought into the effort be required to either fill the gaps not addressed by the first two groups, or be offered the chance to implement initiatives developed by former participants.

These conclude my written observations and recommendations.

Mr. BOUCHER. Thank you, Dr. Leppert, Dr. Moss, and Dr. Glass.

This initiative is fairly new. Tell me, first of all, when you entered into your respective cooperative arrangements with NSF for it. Just within the last several months, as I understand it. Is that correct?

Dr. LEPPERT. That is correct.

Mr. BOUCHER. How much money per state is NSF providing per year for the 10 states that are now participating?

Dr. Moss, Dr. Leppert?

Dr. MOSS. The program is $10 million over five years from NSF if NSF has the resources to carry it out. So it would basically be $2 million a year. Usually, in our State, it is matched fully by the State, so it becomes a $4 million program.

Mr. BOUCHER. Is that the basic requirement, that it be matched with an equal amount of funds from the non-Federal sponsor?

Dr. MOSS. I am not sure that is a requirement. Certainly our application was enhanced by that commitment from the governor. That is the kind of commitment that I think is needed.

Mr. BOUCHER. All right, so it is a competition among the States for those selected, and obviously, those that have a larger non-Federal share will be viewed perhaps somewhat more favorably.

Dr. MOSS. NSF looked very strongly at the commitment at the top leadership of the State.

Mr. BOUCHER. So it is probably too early to begin to assess the effectiveness of the program, but let me ask you this. What kind of mechanism should we put in place by which we will gauge the effectiveness of this program over time? We need, as you have suggested, to have careful oversight. By what mechanism should that oversight take place? What kinds of tests should we set up along the way?

Dr. Leppert?

Dr. LEPPERT. I might also add that NSF has requested that each of us have a major evaluation component to our program. I have just employed a major evaluator with significant credentials in the field who will look both at the formative processing of the operation of the grant as well as seek a number of outcome measures. Those will be reported and coordinated through NSF.

They also have a technical assistance grant that is being provided. Evaluation will be a major component of that effort. When that grant is awarded, I presume we will all be pulled together and will seek to coordinate our efforts at evaluation through the technical assistance grantee.

Unfortunately, within NSF itself, they really only have two staff people operating these ten grants, and they are spending most of their time out in the field selecting next year's class. And so there are some limitations in terms of staff time at NSF in working with us in defining our evaluation instruments.

But each of us are moving forward and developing appropriate instruments tied to our objectives.

Mr. BOUCHER. So you are suggesting that the method for evaluation be established at the State level; that it not be something centralized within NSF?

Dr. LEPPERT. Well, for example, the initiative in Ohio is primarily at junior high or middle schools. Ours is primarily at elementary schools and at the freshman-sophomore years at the universities and community colleges. Obviously, we would have to assess those somewhat differently.

Mr. BOUCHER. All right.

Dr. Moss?

Dr. MOSS. That is the $64 question I think you have asked, Mr. Boucher. It is a tremendously difficult thing to figure out the right assessment. The traditional ways of assessment are about as sterile as the traditional ways of teaching, and if we have assessment that is based on the number of workshops we have or meetings or people attending them, and so on, we are just going to have a continued mess.

Somehow we have to look at whether we are getting more students interested in science and mathematics, more variation of students, minority students, females more interested in science and mathematics education, whether they are more excited about it, and whether they are carrying that through into their upper high school years and then into college.

The conventional way, just measuring test scores, is not going to really tell us whether we are succeeding in creating more excitement for science and math education. That is where I think the States are really going to have to work together, and I hope NGA and NCSL and NSTA and some of the other national organizations will help us in these assessment things, because NSF will not be able to do it alone.

Mr. BOUCHER. When is the time at which this subcommittee ought to have you come back, or you and other witnesses come before us, and ask the question about how successful this has been? I know we cannot do it now; you have just begun. But can we do it a year from now and expect to get clear answers, or is this something that we have to wait until the end of the five-year period to really begin to evaluate?

Dr. Leppert?

Dr. LEPPERT. We will have in place a number of products within a year. In fact, we will have in place by the end of this summer a number of significant products. We are moving as if this is a national crisis, and we intend to have our objectives identified by the end of March. We hope to have hundreds of teachers pulling together and evaluating materials during the spring and summer.

We have already in place the database looking at our freshman-sophomore enrollment in science courses. We will have that as baseline data and will be able in two or three years from now clearly to see if there have been trends in the enrollment of students in the basic sciences in the lower divisions of universities and to see whether that has impacted on the widening of that funnel that has been so constraining our supply of both scientists and scientifically literate teachers.

Mr. BOUCHER. Dr. Moss?

Dr. MOSS. I would like to see you ask us every year, and I would like NSF to be asking us about results more frequently than once a year. The system can relax so easily back into the notion that we are just administering a Federal program that we need to be jarred out of that thinking and into the thinking that we are setting the strategic directions for improving science and math education, and people are interested in what we are doing. Your repeated oversight on that will be a very helpful spur for that.

Mr. BOUCHER. Dr. Glass, I don't mean to exclude you from this. Do you want to comment on any of this range of questions?

Dr. GLASS. No, I guess I concur with what has been said. I think the caution, though, that you need to be careful on is that you do not get a laundry list of workshops conducted, textbooks evaluated, et cetera. It is relatively easy to fall into that trap.

The real goal, I think, should be the same for all SSI programs, and that is to increase the scientific literacy of all Americans. And with an emphasis on the word "all." I would be a little concerned if you look only at it as a pipeline question.

Mr. BOUCHER. What should the NSF be doing to better assist you as you carry this initiative forward that it is not doing today? Are you getting enough technical support and assistance, or are there things the NSF ought to be doing to assist you in this?

Dr. Leppert?

Dr. LEPPERT. As I did mention briefly, I am really looking forward to the wording of a grant to some national entity to provide technical assistance. There is about a $1 million RFP that was on the street here a few months ago, and I believe they are close to closing on an awardee.

Mr. BOUCHER. Is that going to be enough money to provide the assistance you need?

Dr. LEPPERT. Well, if there are 20 States, that is about $50,000 worth of service per State.

Mr. BOUCHER. Is that enough?

Dr. LEPPERT. I could use a little more. For example, I would really like to be able to access and have evaluated all other instructional development projects that NSF has funded in the public schools, in the elementary schools, for curriculum development, for example, over the last five or ten years. That information is not easily accessed, and it certainly is not easily evaluated in light of our objectives. And that type of technical assistance could be perhaps more usefully done at a national level because it would serve many States at the same time.

Mr. BOUCHER. Dr. Moss?

Dr. MOSS. I think the best thing NSF can do is bring us—that is, the SSI states—together to talk about how we are handling some of these institutional problems. We can learn from each other.

I am less enthused about the technical assistance program. We have curricular specialists in the States. We have equipment often in the closets, as I said in my statement. What we do not have are ways to break down the institutional barriers, and I think we have to gel ourselves as a working group.

The States have a lot at stake at this. We have said we could do it. We have made a national commitment to do it, and we will have a lot of motivation to work with each other and try to make this succeed if we are really talking to each other as a group.

Mr. BOUCHER. That is a very interesting idea. How often do you think you should get together as a group to discuss your progress?

Dr. Moss. Of course, it depends on who gets together, what aspect of it, but more than once a year, that is certainly true. Frankly, I would do it more than twice a year.

Mr. Boucher. Has the NSF announced any plans to bring you together?

DMr. Moss. They did have a workshop in the fall. I don't know when the next is scheduled, but it has to be frequent.

Dr. Leppert. They have announced one. I believe it is May 5 and 6.

Dr. Moss. And there are more ways to do it than at formal meetings.

Mr. Boucher. So it sounds like they are already doing on at least a six-month basis. Do you find that appropriate, Dr. Moss, or do you think they ought to be doing more?

Dr. Moss. I think it is appropriate. I think it can be done more creatively than the fall meeting was done, at least I understand from my colleagues. I don't know if you would agree, Mr. Leppert.

Dr. Leppert. I would.

Dr. Moss. It is as difficult to do assessment creatively as it is to teach science creatively, and so we have to jar ourselves out of some of these old patterns of assessment, just as we have to jar ourselves out of old ways of teaching science and math.

Mr. Boucher. Thank you for your recommendations.

The gentleman from California.

Mr. Packard. Thank you very much.

I think it is obvious that I have been shuffling back and forth to another committee which I am ranking on, and that is why I am not seeing you all during your testimony, and I apologize for that, but I have reviewed it.

Dr. Moss, you mentioned that parents ought to be more involved in the improvement in science and math education. Does Ohio have a special program where you have involved the parents?

Dr. Moss. Not in the State as a whole, but in our area in northeastern Ohio, we have tried things. We have science fairs for parents. We bring them in and they do some science experiments. It is amazing. Usually parents during these school things are out in the hallway drinking coffee and the programs are droning on in the classrooms. In this one, when we have done it, the parents are in the classroom doing the experiments and having a lot of fun. These inquiry-based lessons of the kinds I will pass out to you are a lot of fun, and people get engaged in it.

But the parents really have to put pressure on us at local levels, as a school board member, to make sure that we are not letting science and math slip.

Mr. Packard. Very good.

Dr. Leppert, a major initiative in the Education and Human Resource Directorate is the Statewide Systemic Initiative which seeks to support integrated changes in science and math, and there are awards given. You mentioned that ten States have received awards and others are being contemplated, among which are my State, California, and Texas.

You mentioned, I believe, that Texas and California have radically different approaches. In what way are they different?

Dr. LEPPERT. What I was pointing out is that our approach is moving away from the traditional textbook approach, and Ohio would be probably in a similar situation. That is, we are looking for people doing science more than reading about it. We are interested in more hands-on, laboratory-based—in the case of Florida, outdoor laboratory-based—learning experiences where groups of students work together to see information, so that there is an inductive approach to the learning style, and that there be more direct experiences rather than the vicarious experiences people typically receive through textbooks or through lectures or through films.

I think that is the difference between learning basketball by playing it or by watching it on television, and we are seeking to put people on the court, if you will.

Mr. PACKARD. Have the awards stimulated activity and change? Are States making genuine improvement, or are they simply making changes to accommodate an award?

Dr. LEPPERT. Mr. Packard, it is my belief that the States are making genuine changes. As Dr. Glass pointed out, there is a great excitement, not only in the award States but in the other States, over this issue of systemic change.

There is a recognition that the entire system must change, and we often find people thinking that science education may be that exciting way to effect that change. We see people thinking of math and language as tools of science. We see people talking about extended school day, Saturday classes where you can have a Saturday lab all day long. We see experts coming into classes and out of classes.

We also are using in our State hundreds of teachers to actually develop the materials that will be used. We are developing source books for teachers, and we are having teachers do this so that it is not a top-down approach to the redirection of the activities within schools.

Those are but a few examples, really, of what we are thinking about in terms of systemic change. It goes well beyond that into the teacher preparation process.

Dr. MOSS. If I might add, Mr. Packard, I do not want to blame the state of textbooks on California and Texas, though people often tend to do that. But one of the things that we know we have to change is that a typical science textbook will have about as many vocabulary words in it as a typical first- year foreign language course.

That is not the way to teach science to kids. It gives them the notion that it is a bunch of memorized terms. We want to go to a whole new concept of science as understanding, and that is going to be new textbooks. I hope Texas and California will help us get those textbooks.

Mr. PACKARD. Thank you.

Mr. BOUCHER. The Chair thanks the gentlemen and expresses the thanks of the subcommittee to this panel of witnesses. We will look forward to your continuing advice as this particular initiative matures.

There being no further business to come before the subcommittee today, the subcommittee stands adjourned.

[Whereupon, at 12:33 p.m., the subcommittee adjourned, to reconvene at the call of the Chair.]

THE NATIONAL SCIENCE FOUNDATION

TUESDAY, MARCH 3, 1992

U.S. House of Representatives,
Committee on Science, Space, and Technology,
Subcommittee on Science,
Washington, D.C.

The subcommittee met, pursuant to recess, at 1:40 p.m. in room 2325, Rayburn House Office Building, Hon. Rick Boucher [chairman of the subcommittee] presiding.

Mr. Boucher. The subcommittee will come to order.

This afternoon, the Subcommittee on Science will continue its oversight hearings on the National Science Foundation. Last week, representatives of professional scientific societies and universities testified on some of the program priorities that are represented in the fiscal year 1993 Administration recommendation for the National Science Foundation. Testimony was also received on specific aspects of the Statewide Systemic Initiative which is designed to reform science and math education.

Today we are pleased to have with us Dr. Walter Massey, the Director of the Foundation, accompanied by Dr. Fred Bernthal, the Deputy Director. Our witnesses will review the plans and priorities that are reflected in the fiscal year 1993 budget.

The budget continues the healthy growth trend that we witnessed last year. It provides an effective increase of 13 percent above the fiscal year 1992 funding level for National Science Foundation programs. The proposed increase reflects the ongoing commitment to double the NSF budget by fiscal year 1994, based on the fiscal year 1987 level.

We are pleased that the growth will allow the NSF to bolster support for individual investigator and small group awards. The growth will also provide the means for NSF to play a strong role in all four of the interagency research initiatives that are contained in the President's budget, those being global climate change, high performance computing, biotechnology and advanced materials and processing.

We have asked our witnesses today to highlight new initiatives and augmentations to existing programs that are contained in the budget. We are particularly interested in the priorities that the NSF has set and the rationale that led these priorities to be identified.

The NSF has a broad charter for support of science and engineering research and education. We appreciate that the Foundation must balance a daunting array of competing demands in establishing these priorities. Testimony concerning those demands and the reason that certain priorities were selected will be welcomed today.

One funding allocation that we are particularly interested in discussing is that for renewal of academic research facilities. I regret that once again the budget request for the National Science Foundation does not contain funding for the Academic Research Facilities Modernization Program. The subcommittee has received testimony over a number of years on the serious deterioration that exists in research facilities today and on the adverse effects that deterioration has on the ability of universities to perform leading edge research.

The NSF Facilities Program represents the only merit- based facilities program that is sponsored by the Federal Government. For that reason, in the view of this member, it deserves special consideration which has not been provided in the Administration's budget. That program should be nurtured and sustained, not abandoned.

Another issue that we would like to discuss today is the allocation of resources for the interagency research initiatives that are coordinated through the Office of Science and Technology Policy. We note that in the fiscal year 1993 budget, the allocation for four of these initiatives amounts to fully 40 percent of the NSF's research budget. That amount may be too great or it may be too small.

We are in a position of needing to understand the effects that these growing allocations for interagency initiatives will have on the National Science Foundation's core disciplinary programs and on the ability of the NSF to provide funding for unexpected research opportunities. The testimony of our witnesses will be welcome on these matters as well.

We welcome Dr. Massey and Dr. Bernthal to the subcommittee today and before turning to them for their statements, I would like to recognize the ranking Republican member of the subcommittee, the gentleman from California, Mr. Packard.

Mr. PACKARD. Thank you very much, Mr. Chairman.

Dr. Massey, Dr. Bernthal, welcome to our committee. We're looking forward to your testimonies. It's been a pleasure for us to work with you in the past, and we're certainly looking forward to another good year this year.

As I mentioned at last week's hearing, I am very pleased for the increase in the President's budget for fiscal year 1993. The 17.6 percent increase over fiscal year 1992 appropriations is evidence of the President's commitment to double the NSF budget by 1994.

The National Science Foundation is well-positioned to lead this country into the next century with its dedication to basic research and its expanding emphasis on improving science, math and engineering education. There is an intricate relationship among the areas of science, technology and education. The combination of all these areas leads to a more productive work force, which in turn leads to a more competitive national economy.

The Chairman has already outlined some of the issues that we will be discussing today and I would like to mention that the NSF budget this year reflects a broad effort to really increase the support of individual investigators. These people are so vital to the basic research effort funded through the National Science Foundation. I applaud the NSF for placing a greater emphasis on this critical element and as you, Mr. Chairman, look forward to the testimony of our very distinguished witnesses.

Thank you very much.

[The prepared statement of Mr. Packard follows:]

STATEMENT OF
THE HONORABLE RON PACKARD
SCIENCE SUBCOMMITTEE
HEARING ON NSF OVERSIGHT
1:30 PM, 2325 RHOB
MARCH 3, 1992

I AM HAPPY TO WELCOME DR. MASSEY AND DR. BERNTHAL TO THE SUBCOMMITTEE'S HEARING TODAY. AS I MENTIONED IN LAST WEEK'S HEARING, I AM VERY PLEASED WITH THE INCREASE IN THE PRESIDENT'S BUDGET FOR FISCAL YEAR 1993. THE 17.6% INCREASE OVER FISCAL YEAR 1992 APPROPRIATIONS IS EVIDENCE OF THE PRESIDENT'S COMMITMENT TO DOUBLE THE NSF BUDGET BY 1994.

* THE NATIONAL SCIENCE FOUNDATION IS WELL-POSITIONED TO LEAD THIS COUNTRY INTO THE NEXT CENTURY WITH ITS DEDICATION TO BASIC RESEARCH AND ITS EXPANDING EMPHASIS ON IMPROVING SCIENCE, MATH, AND ENGINEERING EDUCATION.

* THERE IS AN INTRICATE RELATIONSHIP AMONG THE AREAS OF SCIENCE, TECHNOLOGY, AND EDUCATION.

* THE COMBINATION OF ALL THESE AREAS LEADS TO A MORE PRODUCTIVE WORKFORCE WHICH, IN TURN, LEADS TO A MORE COMPETITIVE NATIONAL ECONOMY.

* THE CHAIRMAN HAS ALREADY OUTLINED SOME OF THE ISSUES THAT WE WILL BE DISCUSSING TODAY. I WOULD LIKE TO MENTION THAT THE NSF BUDGET THIS YEAR REFLECTS A BROAD EFFORT TO REALLY INCREASE THE SUPPORT OF INDIVIDUAL INVESTIGATORS. THESE PEOPLE ARE SO VITAL TO THE BASIC RESEARCH EFFORTS FUNDED THROUGH THE NATIONAL SCIENCE FOUNDATION. I APPLAUD NSF FOR PLACING A GREATER EMPHASIS ON THIS CRITICAL ELEMENT.

* THANK YOU, MR. CHAIRMAN.

Mr. BOUCHER. The Chair thanks the gentleman.

The gentleman from Indiana, Mr. Roemer.

Mr. ROEMER. Thank you, Mr. Chairman.

I too would like to welcome the witnesses to our hearing this morning. I just recently had the pleasure of hearing Dr. Massey testify last week to a joint Science, Space Technology and Education and Labor Committee hearing, and I look forward to some of his testimony here today as well too.

We talked last week about some of the tough choices that we have to make, and it's always a tough thing to say in this room because of the great surroundings and our tribute to space. But I talk much about some of the tough choices that we have to make on a Space Station versus education, manufacturing, future investment in our middle class in this country. And I look forward maybe to engaging, if I can stay long enough, both of you in some questions along those lines.

I also salute both of you too for your fighting successfully for increases in your investment in our colleges and universities and our young people which does increase our future competitiveness in this country. We are facing some very, very difficult decisions and some tough times. We have a budget vote coming up later this week; we had some votes on a tax package last week; and I think that you both need to help us with some guidance and expertise on how to make the best informed choices and votes here.

Just last week in the Science Section of the New York Times, they indicated that for the first time, the United States has not only fallen behind the Japanese in semiconductors and consumer electronics; we just heard testimony that we're starting to be worried about aeronautics, supercomputers; now it's research. Our companies, industrial as well as Federal research monies, are going to be overtaken by Japan for the very first time.

So we have to change some things and get some new priorities. I look forward to hearing both of you and to working with both of you in the future as well.

Thank you, Mr. Chairman.

Mr. BOUCHER. The Chair thanks the gentleman.

The gentleman from New York, Mr. Boehlert.

Mr. BOEHLERT. Mr. Chairman, first of all, let me ask unanimous consent that these eloquent words prepared by my staff be placed in the record at this point.

Mr. BOUCHER. Without objection, so ordered.

[The prepared statement of Mr. Boehlert follows:]

Thank you, Mr. Chairman. I Want to join in welcoming our distinguished guests: Dr. Walter Massey and Dr. James Duderstadt.

With the tough budget climate facing us this year, and for every year into the foreseeable future, it is critical that we work together to set priorities.

I feel that in making choices among all the worthy projects and programs that come to Congress for funding, we need to choose those that promise the greatest returns for the future. We should look at each program for what it represents as an investment in our future. By this standard NSF is a shining star in the government and fully deserving of the 18% increase requested by the President.

The foundation's basic mission is to support our scientific research base. In recent years, new missions have been overlaid on the old-new initiatives have been undertaken in education, establishing national science and engineering centers, setting up Supercomputer centers that benefit all researchers, and as an active participant in FCCSET initiatives.

I look forward to hearing from Dr. Massey and Dr. Duderstadt on the future of NSF, and perhaps how the Foundation has been setting priorities for itself. But I want to assure you that keeping the NSF strong and vital is at the top of my list of priorities.

Mr. BOEHLERT. Let me just speak from the heart. First of all, I'm a cheerleader for NSF as both of you know, both of the witnesses know. I can't think of a greater investment we can make in our future than to give you the resources that you need to perform your very important work.

Having said that, and having applauded the Administration's significant increase in funding for NSF, I must confess a little disappointment that we don't have any money for the University Research Facilities Modernization Program. I think that's urgent, critically needed for America to make us competitive in the next century. The next century is not way far in the distance; it's less than 100 months away.

While I applaud an increase in the money for science education, quite frankly, we are not putting enough extra in there. Three percent is hardly adequate in my estimation. So I plead guilty to being a spender. This is one of those areas where we have to spend money and it's a wise investment in our future.

Dr. Massey, you've heard me wax eloquently I think on this before, but I couldn't agree more than I do with my colleague from Indiana in terms of setting priorities. I find it mind-boggling, for example, that this country can find an undertaking that requires an installment payment of over $650 million just this year alone. I'm referring, of course, to the Superconducting Super Collider, when we are not doing anything for our university research facilities, when we are not doing enough for education. Where are our priorities?

I don't find that my priority to put all our eggs in that one basket down in Texas—it's not Texas bashing, it's just establishing priorities.

I want you to know that I'm here as an advocate. I'm trying to give you more because I admire what you're doing. I think you've done it exceptionally well and I want to continue to encourage you. I want to hopefully redirect some of those precious scarce resources into areas that I think deserve greater emphasis than they are now receiving and take other projects, and the SSC is one in particular I refer to, and not just discard them completely but put them on the shelf for another time when we have more money. We don't have that resource right now.

Thank you, Mr. Chairman.

Mr. BOUCHER. The Chair thanks the gentleman.

Dr. Massey, we welcome you to the subcommittee this afternoon and we would be pleased to receive your testimony. Without objection, your written statement will be made a part of the record, and we would ask that you inform us orally of the NSF's plans and programs.

STATEMENT OF WALTER E. MASSEY, DIRECTOR, NATIONAL SCIENCE FOUNDATION; ACCOMPANIED BY: FREDERICK M. BERNTHAL, DEPUTY DIRECTOR, AND LUTHER WILLIAMS, ASSISTANT DIRECTOR, EDUCATION AND HUMAN RESOURCES

Dr. MASSEY. Thank you very much, Mr. Chairman.

I do appreciate the opportunity to appear before your subcommittee today to discuss the budget of the National Science Foundation and our plans for the coming years, and the issues that you have raised. As you note, I have submitted written testimony for the record.

As you have pointed out, for the coming fiscal year, the NSF is requesting a total of just over $3 billion, $3.027 billion, to be precise. This represents an increase of 17.6 percent over our 1992 budget. I'm very pleased with the potential in this budget because it demonstrates a commitment to the exploration of the frontiers of knowledge and to using scientific and engineering research and education as a basis for improving the quality of life on our planet.

Recently, there has been a growing concern that as a Nation, we have failed to maximize and capitalize on our strengths in science and engineering. The Foundation has responded to this concern in a number of ways. First, we are working to increase support for individual scientists and engineers, the backbone of our research enterprise. And through the Interagency FCCSET process, we are enhancing our investments by improving the coordination among the various Federal research and development agencies.

NSF has actively also sought ways to work more closely with industry in order to move knowledge more quickly from the research laboratory to the user community. Through our research centers programs, we are supporting work on such topics as hazardous waste management, telecommunications, biotechnology processes, ceramics and intelligent manufacturing systems.

These efforts entail individual scientists, engineers and small groups working to expand the knowledge base needed to understand real world problems and to improve our quality of life. At the same time, they are working to develop the materials and processes that are necessary to provide affordable and practical technologies to solve these problems.

Throughout the agency's history, we have been able to respond rapidly to national need and targets of opportunity and to exploit strategic technologies. Let me give you a few examples that I think will highlight this.

Within days of the Gulf War, scientists working on grants from the NSF were on the scene at Kuwait in the oil fields at the fires gathering atmospheric samples to assess the potential effects of this disaster on the environment.

You may recall there was a great deal of uncertainty about how widespread the effects of the oil fires would have been or would be. The work of these scientists very rapidly disclosed that although the fires resulted in a local ecological catastrophe, the global effects of the fires were far less than feared, thus not only removing a great deal of anxiety but probably removing a great deal of unnecessary expenditures and efforts.

Another example, in the multibillion dollar electronics manufacturing sector, one of the vexing problems is maintaining the purity of materials in the work environment, in the clean rooms and like. NSF has supported research at the University of Arizona on a technique for measuring impurities of less than 1 part per billion. This technique has widespread application, potential application of course not only in the field of manufacturing for semiconductors, but also in such diverse fields as pollution monitoring and studying the effects of various pollutants on the environment.

Moving ideas rapidly from the drawing board to the production line is critical in just in time manufacturing, which is the new mode of manufacturing that will make us more competitive in the world environment.

At our Engineering Research Center at Purdue, research on intelligent manufacturing will allow manufacturers to shrink the time between design and production of a custom-engineered product such as a carburetor for a car, not only the chip in a microprocessor, to as little as 24 hours.

This shortening interval between scientific discovery and its application is one of the hallmarks of our present time and this diminishing time, between research and application is partially a result of improved communications and growing opportunities of cooperation between the academic research community and industry. But it is also based on necessity. Some of our international competitors have shown an exceptional ability to commercial advances in science and engineering, advances that often have been produced in our own laboratories. So successful have others been in commercializing American technology that we sometimes fail to recognize our own accomplishments.

Mr. Chairman, I'd like to take a moment just to highlight one of these accomplishments. Fifteen years ago, no one had ever heard of windshear or microbursts as potential hazards to airliners. In 1977, a University of Chicago professor, a colleague of mine I'm proud to say, Dr. Theodore Fujita, proposed the existence of an unexplained atmospheric phenomenon, a downburst, that he felt could have been the cause of a 1975 crash at Kennedy Airport, a major crash.

This led to a series of experiments supported by NSF through the National Center for Atmospheric Research, NCAR, at Boulder, that resulted in the first physical descriptions of downbursts that were measured by a technique called Doppler radar. In 1984, a 45-day operation of demonstration of this technology resulted in saving at least one aircraft and scores of lives and over $800,000 in fuel costs at Stapleton Airport in Denver. This is just since 1977.

Today, as a result of this rapid transfer of basic research into workable technology, the FAA plans to install Doppler radars at every major airport in the country. This research has resulted in approximately $500 million in new business for American industry and the saving of literally hundreds of lives. It has also given birth to a technology that could provide the new basis for exports for American industry. These are just a few of the many ways in which basic research is being quickly brought to bear on improving the quality of life at home and throughout the world.

Our budget request is covered in some detail in my written testimony, so I won't go into that level of detail now, but I would like to provide, as you requested, an overview of a few highlights.

In research, the 1993 budget request for Research and Related is $2.2 billion, an increase of 18 percent over fiscal year 1992. A large proportion of this increase will go to high priority research areas that have been designated as part of the FCCSET process.

I want to make clear NSF's role in the FCCSET process. As you know, FCCSET is a process that seeks to improve coordination and cooperation among the research and education programs in the various Federal agencies. NSF is a full partner in the FCCSET agenda. It has not been imposed on us, nor do we see it as any way constraining what we do best, supporting individuals in the conduct of fundamental research and education in mathematics, science and engineering.

The existing FCCSET programs, Math and Science Education, High Performance Computing and Communication and the U.S. Global Change Research Programs, were areas of active research at the Foundation long before they became FCCSET initiatives. They continue to be. The type of research, the mix of individual and group efforts, and the criteria by which we review proposals is not affected by being involved in the FCCSET process.

FCCSET, indeed, allows us to focus our attention on our strengths and to coordinate those with the strengths of other agencies. By being a part of FCCSET, these programs are identified as areas with exceptional potential for breakthroughs. As such, they become candidates for enhanced funding.

This year, we propose two additional FCCSET initiatives—Advance Materials and Processing and Biotechnology. Advanced materials are the key to advanced technology. Millions of manufacturing jobs depend upon the development of high quality specialized materials. For example, in 1977, little over a decade ago, silica optical fibers were an experimental material. Just over a decade later, they were being used in transatlantic fiber systems at a cost of 100 times less the copper cable that they replaced.

Currently, the Foundation is providing over $266 million for advanced materials and processing research. This is in our existing programs, prior to the initiative. As a result of the FCCSET Initiative, this will grow by 20 percent to $318 million.

Similarly, in 1992, this fiscal year, we are already supporting research in biotechnology at a level of $174 million. This is an area of research with enormous potential for applications in the fields of health, energy, bioprocessing, the environment, as well as agriculture. Some of the most promising research is in developing microorganisms that will degrade toxic chemicals and others that will dramatically reduce costs and manufacturing processes. In fiscal year 1993, we are requesting an 18 percent increase in our biotechnology research activity.

These areas—materials and biotechnology—have been selected as FCCSET initiatives because of their potential to yield significant advances in scientific understanding and in applications that can improve our quality of life, and because they can benefit from multiagency coordination..

You asked in your opening remarks, are we limiting our flexibility by designating programs as FCCSET initiatives? The answer is no. These initiatives are selected because we anticipate they will be areas of rapid advance, and by knowing what other agencies are doing, we can effectively fill in gaps and avoid duplication and overlap. If a new discovery were to occur tomorrow that would benefit from additional research, I think the mechanism is in place whereby NSF and its sister research and development agencies could form a mechanism to address those research potentials.

Another key to developing and sustaining quality of science is our support for research infrastructure, an area in which you've all shown a great deal of interest.

The Foundation has long supported the unique national facilities essential to research and the budget request this year continues our commitment to provide investigators with access to advance facilities and instrumentation required for world class research. Among the most notable facilities are the Laser Interferometer Gravitational Wave Observatory, LIGO as we call it. It's just a new facility to detect gravity waves. We will begin construction on LIGO in the coming fiscal year at recently announced sites in the State of Washington and in Louisiana.

The Foundation also provides funding for the National Center for Atmospheric Research, NCAR, the world's foremost center for studying the atmosphere. We are funding the National High Magnetic Field Laboratory located in Florida, and that's to provide opportunities for exciting new discoveries in physics, chemistry, biology and materials, science and engineering. We are continuing on our plans towards the construction of two new eight meter optical infrared telescopes.

In the area of research facilities and instrumentation, clearly an area about which you would like to have more discussion, the Foundation is proposing $33 million this year. And as you point out, Mr. Boehlert, as well as the Chairman, we are not requesting funds for facilities within this amount. The $33 million is targeted towards instrumentation, and I'll have more to say about that later when we get into your questions.

In the Antarctic Program, in 1993, the budget request is for $163 million, and these funds are to support research and logistics associated with that program. An additional $14 million is contained in the Department of Defense budget request that will be used for safety, environmental and health activities in the Antarctic. That's on research.

Now I would like to turn to education and discuss the NSF's responsibilities in supporting the development of the highest quality education in science, mathematics and engineering.

As you point out, in 1993, we are requesting $480 million for our Education and Human Resources activity. That is a small percentage increase over our previous activities. I think this committee knows that no one is as strong an advocate for providing support for the improvement of mathematics and science education than I. It is important to appreciate that funding for the education and human resources programs, however, have increased by almost 100 percent since 1990. Over the past five years, our budget for precollege math and science education has grown fivefold. Even this growth fails to fully capture the Foundation's investment in education and human resources because a significant proportion of our research activities funding goes to support programs that provide research experience for undergraduates, improved instructional materials and new instrumentation in undergraduate institutions.

We've looked at all of our programs and when we add up all the NSF programs, we support over 41,400, to be precise, graduate and undergraduate students at over 1200 colleges and universities. When we combine our cross-disciplinary support for education with the monies in the Education and Human Resources budget, the total support from the Foundation is almost $900 million, almost one-third of our total budget. This also exemplifies the very close coupling between research and education that we feel is critical advances in both areas.

While NSF has capitalized on the opportunities created by this rapid growth in funding by investing in a wide range of programs, ranging from the Statewide Systemic Initiatives to summer science camps, to improving faculty development at two year colleges and also programs to improve adult science literacy. We have supported outstanding programs to completely redefine the way we teach, the way we teach mathematics, calculus, in particular, and also programs to develop hands-on activities in all of our schools. We've established programs to encourage underrepresented groups to study mathematics and science, and we've supported and are continuing to support in-service teacher training activities.

The 1993 request provides us with the resources necessary to continue these programs and to consolidate this recent accelerated growth. It also gives us the support and the time needed to organize our education and human resources activities so we can better focus on the management of these programs. I can say more later with Dr. Williams—how we've reorganized the activities, but we feel that this is the year for consolidation.

I'm sure the last thing this committee would want, as we certainly do not want, is for us not to be properly organized to manage the resources we have received over the past four years in this area, and to make sure that our programs are being directed in a way that we can get the maximum advantage from these funds. That's why that increase is as small a percentage as it is this year. It is not a harbinger of the future.

On salaries and expenses, the 1993 request for salaries and expenses is $135 million, and the committee should recognize that $16 million of that is to support relocation expenses for the Foundations' planned relocation to Virginia.

One of my most pleasant surprises on arriving at NSF was to find the quality of talent that we have among the NSF staff, a talent that is evident at every level of the organization. Over the past decade, the Foundation has experienced a near tripling in its program budget for which we are very grateful. This has called for a tripling in the number of proposals we've had to review. The budget hasn't tripled, the proposals have tripled. The staffing level and the expenses are virtually unchanged.

We've made substantial growth in productivity through using computers and through reorganizing efforts, but I think if you look at our salaries and expenses and look at the programs we have to manage, you will agree with me that we should give a high priority to trying to make sure we have the adequate resources to manage the programs properly. I hope I can have your support in making our salaries and expenses of equally high priority as our programs.

I'd like to end just by stressing a concept that will underlie all of our programs and will be the strength, we hope, of our programs, and that is our desire to develop partnerships. The partnerships help us to make the best use of our resources, not only within the academic research community but wherever partnerships can help us gain an advantage.

I mentioned earlier the Statewide System Initiative. This is an example of a partnership between NSF and the States. It is also a partnership that includes industry and academia. Our research centers, which are another mode of research support, are models for partnerships between the Government, universities and industry. We have very high hopes that similar partnerships will grow out of our new FCCSET initiatives. The FCCSET initiatives themselves, I think, are an excellent example of Federal agencies forming partnerships to make better use of our Nation's resources.

In conclusion, I spoke at the outset of the importance of this budget as a reflection of the country's commitment to scientific research and education. It is perfectly justifiable for us to invest in expanding the edges of our understanding and in the creation of new knowledge.

We, at the Foundation, also feel it is equally important that we evaluate and hold ourselves accountable for developing the ties that will enable us to put the knowledge that we're developing to best use. This is true whether the ultimate use is to improve math instruction in grade schools or to solve industrial problems on a supercomputer.

I would just like to reemphasize the priorities that underpin this budget this year, our request. Our highest priority remains people, the individual scientists and engineers whose research we support and also the future generations of scientists and engineers we are trying to develop. It also includes the hardworking staff and employees at the Foundation who administer and manage these programs.

Our second priority is to provide the instrumentation and equipment necessary to conduct the research we support. Finally, we have a responsibility to assist in developing strategies to provide for the maintenance and renovation of research facilities. I believe those priorities are effectively represented in this budget request, and I certainly look forward to a new year working with your committee and you, Mr. Chairman, to try to implement these priorities.

That concludes my testimony and I, along with my colleagues who are here with me, would be happy to answer any questions you or members of the committee may have.

[The prepared statement of Dr. Massey follows:]

Testimony Of

Dr. Walter E. Massey

Science, Space and Technology Committee

Subcommittee on Science

March 3, 1992

Mr Chairman, I appreciate the opportunity to appear before your subcommittee today to discuss our budget request and the upcoming plans of the National Science Foundation.

For the coming fiscal year we are requesting a total of just over 3 billion dollars -- $3.027 billion to be precise. This represents an increase of 17.6 percent over FY 1992.

I am very pleased with the potential in this budget, not only because of the size of the increase that it contains, but because it demonstrates a growing commitment to scientific and engineering research and education as a basis for improving quality of life on our planet.

The National Science Foundation has grown and evolved dramatically since its beginnings in the early 1950's. During our first decade, the average NSF budget (in 1992 dollars) was only about six percent of what it is today. After the launch of Sputnik NSF became a major focal point for the national call to improve mathematics, science, and engineering education. Since that time, we have been a driving force in developing and maintaining the academic research capabilities of our colleges and universities -- programs second to none in the world.

Recently there has been a growing concern that, as a nation, we have failed to maximize our strengths in science and engineering. NSF has responded to this concern in a number of ways. We are vigorously working to set priorities in strategic areas, increase support for individual investigators -- the backbone of our scientific and engineering enterprise -- and improve the coordination among scientific agencies within the Federal government. NSF has also actively sought ways to work more closely with industry in order to move new knowledge more quickly to the user community. Through our research centers programs we are supporting work on such topics as hazardous waste management, telecommunications, biotechnology processes, ceramics and intelligent manufacturing systems.

These efforts entail individual scientists and groups of scientists working to expand the knowledge base needed to understand real-world problems. At the same time they are working to develop the materials and processes necessary to develop affordable and practical technologies to solve those problems.

NSF's flexibility has enabled the foundation to respond rapidly to targets of opportunity and to exploit strategic technologies. Let me give you some examples:

- Within days after the Gulf War, scientists working on grants from NSF were on the scene of the Kuwait oil field fires, gathering atmospheric samples to assess the potential effects of this disaster on the environment.

- In the multi-billion dollar electronics manufacturing sector, one of the most vexing problems is maintaining purity of materials in the work environment. NSF has supported research on a technique for measuring impurities of less than one part per billion. This technique has wide potential application not only in the manufacture of semiconductors, but also in pollution monitoring.

- Moving ideas rapidly from the drawing board to the production line is critical in a "just in time" manufacturing environment. At the Engineering Research Center at Purdue research on intelligent manufacturing will allow us to shrink the time between design and production of a custom-engineered product to as little as 24 hours.

The interval between a scientific discovery and its application has been steadily diminishing. This is partially the result of improved communications and growing opportunities for cooperation between the academic research community and industry. But it is also based on necessity. Our international competitors have shown an extraordinary ability to commercialize advances in science and engineering -- advances that have often been produced in our laboratories. So successful have our rivals been that we sometimes fail to acknowledge our own accomplishments. Let me take a moment to highlight one of these.

Fifteen years ago no one had ever heard of wind shear or "micro bursts" as potential hazards to airliners. In 1977 a University of Chicago professor, Dr. Theodore Fujita, proposed the existence of an unexplained atmospheric phenomenon, a downburst, that he felt could have caused a crash at Kennedy Airport two years earlier.

This led to a series of experiments supported by NSF through the National Center for Atmospheric Research which, in 1982, resulted in the first physical descriptions of downbursts measured by Doppler radar. Two years later a 45-day operational demonstration of this technology resulted in saving at least one aircraft, scores of lives, and over $800,000 in fuel costs at Stapleton Airport in Denver.

Today, as a result of the rapid transfer of basic research into workable technology, the FAA plans to install at least 47 Doppler radars around the country. This research has resulted in approximately $500 million in new business for American industry and the savings of hundreds of lives. In addition, it provides untold potential for exporting these and similar critical weather detection technologies to other countries.

I would like to move on to a few of the highlights of the budget and I will address each of these in greater detail as we go on.

RESEARCH

The FY 1993 budget request for Research and Related Activities is $2.2 billion, an increase of 18 percent over FY 1992. The request emphasizes core support for individual investigators, primarily through continued growth for the high-priority FCCSET areas of Advanced Materials and Processing Program, Biotechnology, High Performance Computing and Communications, U.S. Global Change Research Program, as well as NSF initiatives in support of environmental research, manufacturing, and plant sciences.

I want to underscore NSF's role in the FCCSET process. As you know, FCCSET is an effort to provide greater coordination among targeted research programs in the Federal government.

NSF is a full partner in setting the FCCSET agenda. It has not been imposed on us and it does not in any way constrain what we do best -- support fundamental research and education in mathematics, science, and engineering.

The existing FCCSET programs -- Math and Science Education, High Performance Computing and Communication, and the U.S. Global Change Research Program -- were areas of active research at NSF long before they moved to center stage through FCCSET, and they continue to be. The type of research, the mix of individuals and group efforts we support, and the criteria by which we review proposals is not affected. FCCSET allows us to maximize our investment in these high priority areas through coordination and cooperation with other R&D agencies. By being a part of FCCSET these programs are identified as areas with exceptional potential for breakthroughs. As such, they become candidates for enhanced funding.

Many of these areas reflect the complexity and multidisciplinary character of today's forefront research issues. This is illustrated by the increasing need to cooperate across fields of research and share data, instrumentation, and equipment. Research highlights include:

- **Advanced Materials and Processing Program (AMPP):** The Foundation's support of this program will total $318.5 million in FY 1993, up 20 percent over FY 1992. Because nearly every research field is materials-limited, the creation, production and use of new materials is viewed as critical to the nation's technological progress and productivity. AMPP will help to bridge the gap between basic research knowledge and the application of the research to improve the invention, processing and performance of materials. The Foundation's budget request supports this interagency FCCSET initiative to advance our fundamental understanding of the behavior and properties of materials.

- **Biotechnology:** NSF funding for this FCCSET initiative will increase by 18 percent to a total of $205.6 million in FY 1993. The U.S., a leader in biotechnology, today faces keen competition from Japan and Europe. The recent appeal of biotechnology is due to the intrinsic social and economic value of many of its products, its unusually low fossil fuel demands, and its promise to provide ways to improve the environment.

  Biotechnology involves many scientific and engineering fields working in multidisciplinary partnerships. The Foundation's request supports this FCCSET initiative to strengthen research in agriculture, health, energy, bioprocessing/manufacturing, and the environment.

  High Performance Computing and Communications (HPCC): NSF funding for the second year of this program will total $262.0 million in FY 1993, up 30 percent over FY 1992. Progress and productivity in research are increasingly dependent on the management of large complex databases, the exercise of massive computer models, shared access to information processing and computing resources, increasingly powerful machines, instruments, and close interaction with people located in remote places.

  The Foundation's request supports groups and centers focused on grand challenges and related basic research; access to and experimentation on advanced high performance parallel computers, educational programs in computational science and engineering; and access to high performance computing centers for precollege and undergraduate students and the deployment of the interim National Research and Education Network (NREN).

- **U.S. Global Change Research Program (USGCRP):** The Foundation's request supports the FCCSET Committee on Earth and Environmental Sciences FY 1993 plan to expand the scope and interagency responsibility for this important program. The Foundation's support for this program will total $162.5 million in FY 1993, up by 50 percent from FY 1992. As one of eleven federal agencies engaged in this initiative, NSF support focuses on the basic research necessary to understand and ultimately predict future changes in the earth's environment, and the human dimensions associated with these changes.

- **Advanced Manufacturing:** The Foundation's support will total $104.5 million in FY 1993, a 31 percent increase over FY 1992. Maintaining a high quality manufacturing base is essential to compete in world markets, sustain economic growth, and maintain a strong national defense. Advanced computers and information technologies will enable new approaches for major improvements in our research and education programs, which will ultimately impact our manufacturing and production systems across a wide spectrum of U.S. industries. The Foundation's support will provide a new and expanded focus on the integration of design, manufacturing and business management processes and new experimental methods for the rapid prototyping of new products and new manufacturing systems.

- **Multidisciplinary Research on the Environment:** The Foundation's support for this program will total $118 million in FY 1993. Environmental quality and technological progress, once at odds, now find they are at risk in the United States. The Foundation's support will focus on integrated basic research to provide fundamental understanding across major areas of science and engineering; develop and implement new approaches to basic research on the environment; and build scientific infrastructure and human resource capability.

The Foundation has long supported unique national facilities essential to research capabilities. The budget request continues the commitment to provide investigators with access to advanced facilities and instrumentation required for world-class research. Among the facilities highlights are:

- Opportunities to verify, measure and study gravitational waves and black holes, thus revealing new information about the universe, are the objectives of U.S. scientists in the construction of the **Laser Interferometer Gravitational Wave Observatory** (LIGO). Construction of LIGO began in FY 1992. Two identical widely-separated detectors will be built for fundamental physics experiments to directly detect gravitational waves and gather data on their sources. The Foundation's support for this project will total $48.0 million in FY 1993.

The Foundation will provide increased support to other unique facilities that hold the promise to advance science in significant ways including: the **National Center for Atmospheric Research (NCAR)**, the world's foremost center for studying the atmosphere; the **National High Magnetic Field Laboratory**, providing opportunities for exciting new discoveries in physics, chemistry, biology, and materials sciences and engineering; two **8-Meter Optical/Infrared Telescopes** advancing the astronomical sciences; and the preliminary design of an Arctic research vessel.

ACADEMIC RESEARCH FACILITIES AND INSTRUMENTATION

The nation's capability to perform world class research, improve its research competitiveness, and provide the best training for future scientists and engineers is dependent on state of the art instrumentation. Through this special instrumentation program, support is provided for the purchase, development, maintenance and operation of major research instrumentation to advance our nation's research laboratories and training efforts. Cost sharing of at least 50 percent will be required. The Foundation's program will total $33.0 million in FY 1993, the same as in the FY 1992 Current Plan. The FY 1993 budget requests funds only for academic research instrumentation.

U.S. ANTARCTIC PROGRAM

The U.S. Antarctic Program supports national goals to maintain the Antarctic Treaty and ensure that the continent continues to be used only for peaceful purposes. This program supports scientific research that will contribute to the solution of regional and world-wide problems, protect the environment, and ensure the equitable and wise use of living and non-living resources.

The FY 1993 Budget request for the U.S. Antarctic Program is $163 million. An additional $14 million has been requested by the Department of Defense to support safety, environmental, and health activities.

I would be remiss in not mentioning the difficulties that the USAP faced during the FY 1992 research season due to the continued controversy over the scoring of USAP logistics. Because of the precarious nature of this funding, abrupt evacuations were a constant threat. This is not an optimal way to run an important research program, especially given the significant safety risk of operating in the hostile Antarctic environment. This uncertainty caused a tremendous amount of confusion for the logistics providers, as well as the scientists. Research, safety, health, and environmental activities were all negatively impacted by this situation. In FY 1993, we have proposed to support both the research and logistics in our budget. I hope that the Congress will recognize the importance and need for this approach.

EDUCATION

NSF also has a major responsibility in providing support to ensure the availability of the highest quality education in science, mathematics, and engineering. In FY 1993, we are requesting $479.5 million for our Education and Human Resources Activity. In addition, we intend to carry over in to FY 1993 the $23 million appropriated last year for the new graduate traineeship program.

With the development and initial implementation of our Statewide Systemic Initiative, NSF has undertaken an experiment in revitalizing education at the state level that is nothing short of revolutionary. We have initiated a new program -- Alliances for Minority Participation -- that seeks to make a measurable improvement in the number of minorities in the fields of science, engineering and mathematics. We have also looked at ways that technology can enhance education and I am very excited about the potential for the National Research and Education Network (NREN) to revolutionize the way we think about teaching science.

The education and training of future scientists and engineers is crucial to the development of knowledge and to the nation's future. The link between world-class research and new technologies and products depends on strengthening our human resource base.

In the course of just three years, NSF's funding for education related programs has increased by 93% -- our Education and Human Resources budget request for FY 1993 approaches a half billion dollars. I feel that we have capitalized on the opportunities that have been created by the recent rapid growth in funding by investing in programs in systemic reform, teacher enhancement, instruments for undergraduate institutions, summer science camps, informal science education, and improving faculty development at two-year colleges.

The Foundation serves as a catalyst in the field of science and engineering education, fostering partnerships among institutions, disseminating knowledge, and bringing together talented people. These programs are funded throughout the Foundation with the Education and Human Resources Activity serving as a focal point for these efforts.

Education and Human Resources activities have been given steady increases in budgets and responsibilities. This rapid growth, together with national efforts to achieve significant gains in educational achievement by the year 2000, has stimulated a reconsideration of the EHR organizational structure. The FY 1993 request consolidates recent accelerated growth and through reorganization, focuses programs and streamlines management.

The request emphasizes systemic approaches to science and mathematics education and to human resources development. Priority is also given to efforts to extend electronic networks and stimulate distance learning and dissemination at the K-12 level through the National Research and Education Network (NREN). Special attention is directed to faculty at two-year colleges and to women faculty.

The Foundation's activities to provide intellectual infrastructure encompass all educational levels: K-12, undergraduate, graduate, and postgraduate, as well as activities to promote public science literacy. Interagency planning and coordination is accomplished through the FCCSET Mathematics and Science Education initiative. When all of NSF's programs are considered, this budget will support approximately 41,400 graduate and undergraduate students at some 1,200 colleges and universities in FY 1993.

Even this growth fails to fully capture NSF's investment in education. A significant proportion of our Research Activities funding goes to support programs that provide research training for graduate students and post-docs, research experiences for undergraduates, improved instruction, and new instrumentation in undergraduate institutions. When all of NSF's programs are considered, we will provide approximately $1.5 billion to support the education of over 60,000 undergraduates, graduate students, post-docs, and teachers of mathematics and science in this country.

CRITICAL TECHNOLOGIES INSTITUTE

The FY 1993 Budget requests $1.0 million to establish a Critical Technologies Institute, a Federally funded research and development center to provide analytical support to the Executive Branch. Policy guidance for the Institute will be provided by an external Operating Committee which will also serve as the Institute's governing body. The Institute will identify near-term and long-term objectives for research and development and provide options for achieving those objectives.

SALARIES AND EXPENSES

The FY 1993 request for Salaries and Expenses is $135 million, an increase of 23.9 percent over the FY 1992 Current Plan. Over the past decade NSF has experienced substantial increases in its program budget and a near tripling in the number of proposals reviewed, while the number of Full-Time Equivalent positions has remained virtually unchanged. While we have made substantial gains in productivity through our automation efforts, our budget request for this activity reflects the high priority I attach to adequate staffing and related support. This has placed an increased strain on our ability to manage our programs effectively, a strain that can only be relieved by providing funds for additional staff. Within this activity, our request includes $16 million for the relocation of the Foundation's headquarters and initial reimbursement to the General Services Administration for FY 1992 relocation expenses.

INSPECTOR GENERAL

The FY 1993 request for the Office of Inspector General Activity is $4.0 million, an increase of 14.3 percent over the FY 1992 Current Plan. The Office of Inspector General is responsible for reviewing and evaluating the financial, administrative, and programmatic aspects of NSF activities and investigating charges of misconduct in science and engineering.

PARTNERSHIPS

One area of emphasis at NSF that is not evident in the raw budget numbers is our attention to developing partnerships that I mentioned previously. This is a concept that we are incorporating into many of our new and existing programs to make the best use of our resources, not only within the academic research community, but wherever we can gain an advantage.

I alluded earlier to the Statewide Systemic Initiative as an example of a partnership between NSF and the states, but it is also a partnership that includes industry and academia. Under EPSCoR, our Experimental Program to Stimulate Competitive Research, a similar partnership arrangement has enabled states to develop quality academic research and education programs with the added advantage of having industrial input from the outset.

Research centers, another model for partnerships, have helped forge closer ties between academic scientists and engineers and their colleagues in industry. We have very high hopes that similar partnerships will grow out of our new FCCSET initiatives in advanced materials and biotechnology.

Other types of partnerships can be promoted through computer and information networks supported by NSF. The natural bridges that exist between research and education come to life at the push of a button when graduate students and undergraduates can work with senior scientists on NSF-supported research and learn science by doing science.

CONCLUSION

I spoke at the outset of the importance of this budget as a reflection of the country's commitment to scientific research and education. It is perfectly justifiable for us to invest in expanding the edges of our understanding and creating new knowledge. It is equally important that we evaluate and hold ourselves accountable for developing the ties that enable us to put that knowledge to use. This is true whether the ultimate use is to improve math instruction in grade schools or solve industrial processing problems on a supercomputer.

Before concluding, let me re-emphasize that the priorities underpinning this budget request, as they have been in previous years, are: People -- the individual scientists and engineers whose research we support, the future generation of scientists and engineers, and the dedicated employees at NSF who administer and manage our research programs; instrumentation and equipment necessary to conduct the research we support; and facilities, as we assist in developing strategies to provide for the maintenance, renovation, and development of national research facilities.

I believe that these priorities are very effectively represented in our budget request and I look forward to working with this sub-committee to implement them.

Mr. BOUCHER. Thank you very much, Dr. Massey, for that well-prepared and well-delivered statement.

Dr. Bernthal, do you have a statement for us today?

Dr. BERNTHAL. No, Mr. Chairman. I agree with everything that you heard.

Mr. BOUCHER. We certainly welcome you here along with the other NSF personnel who I see in the audience.

Dr. Massey, let me start with the question of academic research facilities. Virtually every witness who has come before this subcommittee and addressed spending priorities at the NSF, both this year and last year, has targeted the need for modernization and upgrades of laboratories and equipment at universities as a very high need. We've had some universities tell us that their ability to do leading edge research is really limited only today by the physical facilities in which that research is conducted.

At a time when we're obviously striving to maintain our international lead in a number of fields, many of which are challenged, I think it's critical that we give our universities every edge and every ability. This is clearly one area where they are telling us we are not doing as much as we should.

I note with regret the Administration's budget request of zero funding for that program function which is authorized for fiscal year 1993 at a level of $250 million. I would ask you if you believe that it is an appropriate priority for this Congress to accept zero funding for that need at a time when you're also asking for 20 percent increase in funding for the upgrading of the national facilities which are under your agency's jurisdiction, and also asking for $33 million for instrumentation. How would you respond to that set of numbers and the expression of virtually every witness who has come before this subcommittee that a lot of help is needed for academic research facilities?

Dr. MASSEY. I think it's a question of priorities, Mr. Chairman. Coming from a research institution myself and having spent this year at the Foundation visiting a number of campuses, I certainly agree with you that this is a high priority, and it's one that we're going to have to address.

Within NSF's budget, it's simply a matter of trying to address all of the important things that the scientific and engineering community feel are important within a limited budget. As I say, our highest priority is to support the scientists and engineers and students who are there. The second is to provide them with the instrumentation and equipment. And the facilities are on the list, but that's third.

In my conversations with members of the community, they don't disagree with our priorities. They simply say they wish we had more money so we could have money for facilities.

Mr. BOUCHER. So you agree that it's more appropriate to have a 20 percent growth in funding for the national facilities than it is to put any money at all into university- based research facilities?

Dr. MASSEY. This year, yes, I would agree with that because we've invested a great deal in these national facilities. Of course these national facilities are used by the same scientists and engineers in universities we're speaking of. Our facilities are not for the use of Federal scientists, so these to us fall in the category of instruments to be used by that scientific community.

As you know, the Foundation is a very interactive agency with the community. We have advisory committees for every division, practically, and so when we put our budget together, we try to have it reflect the advice we're getting from our user community.

Mr. BOUCHER. You answered the question well, as I would have expected you to, but let me note a difference of opinion between the Chairman of the Science Foundation and at least the Chairman of this subcommittee on that particular point.

Dr. MASSEY. Okay.

Mr. BOUCHER. Let me move on to another area that I think does concern us, and this has a bit of a longer view.

We are now devoting, in the Administration's request this year, 40 percent of the total NSF budget to these four interagency crosscutting initiatives, each of which has obvious merit. I heard you say in your remarks that you do not think we are risking research in the core disciplines, nor are we sacrificing opportunities to fund research in unanticipated areas, areas we don't now know about as a result of this devotion of 40 percent of the funds to these crosscutting efforts.

In your opinion, Dr. Massey, do we ever reach a point though when those programs are at risk? Let's suppose, instead of 40 percent, the number was 70 percent. Let's suppose it was 90 percent. Let's suppose the entire budget of the NSF were devoted to these crosscutting initiatives. When, if ever, do we reach a point that we sacrifice opportunities in the core disciplines and shortchange that kind of research, or does that point ever come?

Dr. MASSEY. Well, the 40 percent number eludes me, I must say. I'm not sure how it was arrived at. I think these FCCSET initiatives are not well-understood. The initiatives grow out of research that we are already undertaking. Let me use the biotechnology area this year as an example.

As I said in my testimony, we already support $174 million in the area of biotechnology research. That's not new; that's what we were doing already in the core disciplines, so that research will continue as it was. What we did is to look in the Foundation and see could any synergies be affected by coordinating these activities better across the Foundation and trying to identify ways in which the programs could work together. We identified $174 million of funding in the core disciplines that we said, yes, this relates to biotechnology.

In the FCCSET process, every other agency would do the same thing. Then in the process, we would ask ourselves are there new opportunities that build on this that are consistent with the Foundation's priorities, the Foundation's mode of funding in the same disciplines that we fund that make sense to promote biotechnology. We requested a $32 million increase.

So it's not as if we have core disciplines over here and FCCSET initiatives over here. I think when we present it, perhaps we don't make that clear enough. So it wouldn't be, even if 40 percent is in the FCCSET initiatives, which I'm not sure how that number comes about, it's not as if that's separate from our ongoing program.

Mr. BOUCHER. And the core disciplines get funded within the initiatives and so they are not being ignored?

Dr. MASSEY. Exactly.

Mr. BOUCHER. Any comment on your ability to fund unanticipated research needs as they arise?

Dr. MASSEY. We do that still within these areas because the areas of research are not specified by the Foundation. We use the same method of funding, unsolicited proposals coming in in these areas. So if a new idea comes in, we are prepared to support it.

Mr. BOUCHER. But outside these four initiatives, do you fear that there may be some hinderance in your ability with regard to those opportunities?

Dr. MASSEY. No, not now. I think the balance of funds we have in the initiatives now and the appropriateness of the initiatives is about right.

Mr. BOUCHER. We, last year, had made some recommendations with respect to the laser interferometer project, known as LIGO. I notice that the Foundation has gone ahead with its plans to construct two facilities, one on the West Coast, I believe, in Washington State, and another in the southeast.

One of the recommendations we had made to you was that you try to enlist an international partner. Given the understanding that two of these facilities would have to be built, it would seem appropriate to have one perhaps in Europe and the other in the United States. Half the funding, therefore, could be borne by the international partner.

What efforts, if any, did you make in that direction? Why have you chosen two sites in the United States? Why do we not have an international partner at this time?

Dr. MASSEY. Well, we tried. We had discussions with foreign partners, potential partners. As you know from last year, at one time it looked as if the Germans and the British, the French and the Italians might be going for it. The Germans and the British have postponed theirs, so they are not going to participate in any project. We've had discussions with the French, and we were just simply not able to reach an agreement on either side to proceed on these two.

So rather than postpone the progress that we have been making—and a lot was done last year in the development part of our funding—we thought it was best, and in the end, it would be most cost effective to go ahead with the two here with the understanding that the third one that's going to be required to actually do precise measurements to locate the sources will be done in Europe. So we are working very closely with them, but we just were not able to reach an agreement.

Mr. BOUCHER. And those discussions are ongoing, I take it?

Dr. MASSEY. Yes.

Mr. BOUCHER. I only have one additional question, and then I'll yield to my colleagues. Dr. Bernthal and I had a discussion when we had this oversight hearing last year about the requirement in the U.S. Code that each year the National Science Foundation submit to the subcommittee a three-year estimate of specific projects. This is found in Public Law 100-570. The requirements are quite precise. It requires a budget estimate for each major activity, including each of the scientific directorates.

The idea was to give this subcommittee some sense of what the long-term planning and priorities for the National Science Foundation would be so that our sole source of information about your priorities would not come at the submission of the President's budget each January or February. It would give us a better opportunity to work with you in terms of long-range planning and forecasting.

I expressed some disappointment last year to Mr. Bernthal. That was before your confirmation, Dr. Massey, and he was filling your shoes on an acting basis. I expressed some disappointment in the fact that we were not getting very good information through that submission. In fact, what we were getting was essentially a flat landscape. I think that was the term I used at that time.

To my further disappointment, I look at the document you've submitted for this year, which also is nothing but a flat landscape. It shows for fiscal year 1993 $3 billion; it shows the same exact amount for fiscal year 1994; and the same exact amount for fiscal year 1995. In each of the separate categories, you have the identical budget amount for each of those three years.

You know and I know that this is not the way that the budget will appear when it's presented for each of those years. I want to express the continuing disappointment of this subcommittee that we're not getting any useful information from the Foundation as a result of your fulfillment of this statutory requirement. I would remind you that this statutory requirement was put in place as a part of the clear exchange that was made between the Congress and the Foundation in either 1988 or 1989 in the process of which you received the opportunity to have a multiyear authorization.

What we received in return in order to have better planning and cooperation with you was this requirement for annual and detailed budget estimates. So we're not getting what we sought. I'm not suggesting that we're giving active consideration now to going back to single year authorizations, but it is not beyond the realm of discussion.

I would like to know how you justify these flat estimates year after year, notwithstanding that we're seeking considerably more, and when you think, if ever, we're going to get useful information out of this requirement?

Dr. MASSEY. Dr. Bernthal?

[Laughter.]

Dr. MASSEY. Well, I think you raise a very good point. It's my first year doing this budget cycle, and it's very difficult to know ourselves honestly what those out year numbers are going to be. Our planning is really more programmatic than budgetary. We go through a process of trying to set priorities, discuss it with the Board, especially for the out years. In fact, we're just beginning a new long-range planning process to hopefully develop a new strategic plan that we hope will help us justify future increases now that the doubling will be over for the Foundation.

Maybe one way we could work this is to make sure that our planning process is shared with the committee so that you know our priorities for the future. But we have to work with OMB, and I honestly don't know those numbers myself at this time.

Mr. BOUCHER. Did you make a thorough attempt at flushing these numbers out this year and did you get blocked at OMB? Let's be candid about the process.

Dr. MASSEY. Well, we get back from them what our out year planning numbers should be, and these are the numbers they give back to us.

Mr. BOUCHER. But internally, are you making a little better effort to give us the information we're looking for?

Dr. MASSEY. We will.

Mr. BOUCHER. Well, that helps for the future.

Tell me about your current planning process. I understand that you are developing a long-term plan. This is a five year plan, is that correct?

Dr. MASSEY. We aren't restricting it to just five years. We are looking towards the next century.

Mr. BOUCHER. When do you think this subcommittee will be brought into that process, and at what point will we get information concerning what your plans are?

Dr. MASSEY. Well, we've just begun, as I said, we started in January. Part of our reorganization that you saw was to put in place a staff office to help us in this process, and we'll be going through that in the Foundation. We're reporting the first cut through the Board at our planning meeting in June and as those come out in terms of priorities, whatever the mechanism you find would be useful for us to share it with you.

Mr. BOUCHER. So some time in June we could anticipate getting the information from you concerning this long-term plan?

Dr. MASSEY. Sure.

Mr. BOUCHER. We'll hold you to that.

Thank you very much.

I'd like to yield now to the gentleman from New York, Mr. Boehlert.

Mr. BOEHLERT. Mr. Chairman, before I proceed with the questions, I'd like the record to note that Mr. Perkins has joined our side and the majority will now be on this side of the chair if the trend continues.

Mr. BOUCHER. The Chair congratulates the gentleman on this success.

[Laughter.]

Mr. BACCHUS. Do we get a player to be named later?

[Laughter.]

Mr. BOEHLERT. Let me ask you, Dr. Massey, in your submission to OMB—I know that's the preliminary stages of this whole budgetary process—did NSF ask for any university facilities money? Not instrumentation, I know what you have for instrumentation but university facilities?

Dr. MASSEY. Well, we go back and forth, you know, but we did discuss the facilities, sure, and the need for them.

Mr. BOEHLERT. That's encouraging. So I can take some comfort in knowing that NSF, at least it's recognized, that we have to put some money into our university facilities programs. I can recall reading with some dismay just a couple of weeks ago a front page story in the New York Times about this very issue. It's estimated we need at least $10 billion invested in university facilities. So I can be comforted in knowing that you sense this is an area that requires more attention and you will continue to try to persuade our friends at OMB that maybe they should be of like mind

Dr. MASSEY. Sure. As I said, I recognize the problem and it's one that Dr. Bromley and I, along with other heads of the relevant agencies, have been discussing in trying to come up with a way to address the problem at a scale that can make a difference. I think there are some interesting ideas.

Mr. BOEHLERT. Is OMB represented on FCCSET?

Dr. MASSEY. Yes.

Mr. BOEHLERT. That's too bad.

[Laughter.]

Mr. BOEHLERT. What is a typical principal investigator award, what dollar amount is that?

Dr. MASSEY. About $55,000.

Mr. BOEHLERT. Dr. Fujita, that very interesting story you told us about your colleague at the University of Chicago, was he under some award at that time when he made this significant discovery?

Dr. MASSEY. Yes, the work was supported by the NSF.

Mr. BOEHLERT. So a modest grant and very significant work?

Dr. MASSEY. Exactly.

Mr. BOEHLERT. So the typical one is about $55,000. This is an unfair question. What would you rather have? Would you rather have 13,000 principal investigators funded next year or another installment on the Super Conducting Super Collider?

Dr. MASSEY. That's an unfair question.

Mr. BOEHLERT. It's an unfair question and I won't proceed with that, but we're talking about priorities and I think we can all agree within this room that the principal investigators program not only needs to be encouraged but funding needs to be expanded. I'm somewhat encouraged on one point, disturbed on another. I'm encouraged by understanding that you are getting a lot more applications for principal investigator awards. That's the good news. The bad news is that a smaller percentage of those are funded. Is that correct?

Dr. MASSEY. That's true. The trend over the last several years has been what we call our award rate, the number we can fund out of those we judge to be fundable, has been decreasing. That's true.

Mr. BOEHLERT. Doesn't that present a problem? We start right at the basic level and we're trying to put more emphasis into science education at the elementary level. You've got to start with a structure by having a solid foundation. I don't think we're doing nearly enough there. But then we encourage these bright young people to go on to graduate school and then get their doctorates, but isn't that a disincentive to continue if they see this declining ratio of approvals for principal investigator awards?

Dr. MASSEY. I think it's a problem. It's been discussed in many areas and settings. The fact that although our budget for basic research at universities from the Federal Government has been growing, it's true it hasn't kept pace with the opportunity for research. It is a problem for us.

Mr. BOEHLERT. My concern is, and you've heard me talking about the SSC ad nauseam, we're beginning to place too much emphasis, I think, on some megabucks big science projects. In the process, we're neglecting something critically important. I would hope that I could enlist your support in advancing the basic theory that we need to do more on the basics and that we've got to find some area where we can do less, probably in some of these big megascience projects.

I like bragging points and I think that's wonderful to be able to brag to the world that we're the best, but that's not enough to sell me on the project, particularly the SSC.

Let me ask you another question. We want to get the best and the brightest into our classrooms, particularly at the elementary-secondary level. I was alarmed a couple of years ago to discover that more than 50 percent of our Nation's youngsters in elementary schools are taking science from someone not certified to teach science. It might have been a history major, a French major, a good academic, but not prepared to teach science. Gee, that's not very good from my standpoint. So we're trying to find ways to bring the best and the brightest into the classroom and we're competing with the private sector.

You know the story of the Noyes Scholarship Program, the initiative of Senator Rockefeller and myself, to provide these $5,000 stipends for the junior and senior year science, math and engineering majors in exchange for an agreement on their part to teach two years. And yet there is no funding requested for the scholarship program in this year's budget. Don't you think we should have some funding for that program? Do you think the program is meritorious?

Dr. MASSEY. I think I like that idea. Luther, do you want to address that?

Mr. BOEHLERT. I think I know what the problem is. The problem is sort of a DOE and NSF relationship and the problem is NSF doesn't want to be in the business of monitoring the program and has to make certain they do what they say they're going to do.

Dr. MASSEY. That's right. That was the concern—is that we were put in the position of having to be accountable for a program over which we didn't have the primary responsibility. I think that's our objection.

Mr. BOEHLERT. So it's the accountability that's the problem. Well, can't you put your best minds together with the best minds within the Department of Education now that we're able to have you two, Alexander and Massey, working together and appearing together as you did just last week before a committee?

One of the sad stories is, and I think the Chairman can recall this, a couple of years ago, we had to introduce the Secretary of Education and the Director of the National Science Foundation because they'd never appeared together in any forum, a sad commentary. I'm glad to see you and Secretary Alexander moving in the direction toward cooperation.

So please give this some priority. We have to get good, solid people into the classroom to supplement what we already have to teach these young people the math and science disciplines. I know you don't want to monitor the program to make certain kids do what they say they're going to do as they take the check and run, but I don't think it's going to be an insurmountable problem.

Dr. MASSEY. Well, you know, we now have a memorandum of understanding with the Department of Education. As you note, we do have good relations, not just myself and Secretary Alexander, but Mr. Kearns and Luther Williams work very closely together on the FCCSET Committee, so we can now look at a broad range of areas where we can possibly pool our resources and cooperate. That certainly can be one.

Mr. BOEHLERT. I just have one more and then the others have questions too.

In your salaries and expenses budget, it can be misleading as you look at the end figure. And the figure—it looks like major increases for everyone which is not the case because $16 million, is it, is for relocation?

Dr. MASSEY. That's right.

Mr. BOEHLERT. Of the total, what are your priorities as you look at the remainder of the money you have? How do you best hope to effectively utilize that money?

Dr. MASSEY. We have things spelled out in detail, but we need some increase in staff, a modest increase in the number of FTEs to manage these programs, especially the large ones like the SSI, Statewide Systemic Initiative and they require more management than giving grants. We need to invest and there's a major program to invest in technology. We have to upgrade our computers and the networks.

Mr. BOEHLERT. Well, that's critically important, isn't it?

Dr. MASSEY. Yes, we have to. Otherwise we couldn't even keep up with what we're doing with the number of people we have. The others are just to meet the kind of standard increases that are going to be mandated by Federal salary increases and the like. We're not asking for an extraordinary increase outside of the relocation.

Mr. BOEHLERT. Fine. Thank you very much, Doctor.

Mr. BOUCHER. The Chair thanks the gentleman.

The gentleman from Indiana, Mr. Roemer.

Mr. ROEMER. Thank you, Mr. Chairman.

I'd just like to extend an invitation to Mr. Hayes from Louisiana. Any time he's willing to come back, you're welcome on this side, Jimmy. I know there's a trend down in Louisiana to switch over.

Mr. HAYES. I have no intention of having anyone in Louisiana say that I spoke to someone from Notre Dame, so you have to understand.

[Laughter.]

Mr. ROEMER. All right, Jimmy, those are fighting words.

[Laughter.]

Mr. ROEMER. Dr. Massey, you probably saw the kind of clever cartoon that appeared in many newspapers across the country. It had a picture of a school teacher in front of the class, and she was teaching a science class and geography class at the same time. She asked the question, "Where is the English Channel?" All of a sudden all the kids in the school room at the same time yelled, "Right next to MTV."

Dr. MASSEY. No, I didn't see that.

Mr. ROEMER. I think it says a lot of things. I think it says, first of all—and I get into a school almost every time I'm home because

I'm on the Education Committee. It says, first of all, that our kids do love technology, that they watch TV, that they play Mario and Nintendo games, that they are fascinated by it.

Secondly, when you go into our schools and you find a great piece of software that teaches them something other than these games of destruction that so many of our video games do—there is a great software program called Carmen San Diego. This rewards kids to learn geography and to know things in science and to know where capitals of different countries are and capitals within the United States. They fight for this game within their schoolrooms. We don't have enough availability of this great software.

I sure would like to see more emphasis put on that in our schools, especially in our public schools. You can go into some of the private schools and see that much more available than in our public schools. I don't think that there should be this disparity. I'd like to see those kinds of programs emphasized, that development takes place within the National Science Foundation in those areas.

If you could comment on exactly what are some of the things, the innovative and creative things that you're trying to do within the education budget on education and human resources to get our children interested? We all know the recent studies that have come out and put the United States 13th, 12 nations ahead of us—Switzerland, Taiwan, Hungary, the Soviet Union—all ahead of us in testing in science. What are we trying to do at an early age to capture the imagination and the creativity and the interest of these children?

Dr. Massey. I'll answer briefly but Luther, maybe you can come up and give some more detail to the Congressman.

I think you put your finger on two things that I'd just like to have an overview on. One is the importance of addressing the youngsters at an early age, and this is combined with Mr. Boehlert's comment about the need to enhance the teaching because teachers are so critical. The highest priority within our programs in education and, indeed within the whole interagency FCCSET process, is for teacher enhancement at the elementary level to address these issues.

The other one to point out, to me, is another byproduct of this FCCSET process, and that is that we're looking at ways to combine supportive research in one area with our goals in education in the other that might not have been apparent. For example, in the High Performance Computing and Communications FCCSET initiative, there is one on networking, the National Research and Education Network.

It was originally intended to connect supercomputers and researchers, but now it's clear that network should be extended to schools so that youngsters in all schools, public and private, can have the kind of access to not just the software, but to the facilities that would allow them to do the kinds of things you pointed out. So that is an area where we are combining our support of the most advanced research with opportunities to do something in education.

If you don't mind, perhaps Dr. Williams can add further comments.

Mr. Roemer. Sure. Good to see you.

Dr. WILLIAMS. As Dr. Massey indicated, we are approaching the issue that you raised on several fronts. The highest priority has to do with improving the preparation of the teachers who are in the work force. So it's in-service and it's focused on the better than two million teachers, elementary level, middle school and high school level. We do that through our Teacher Enhancement Program or teaching institutes. Typically, it's an intensive, four week period during the summer with follow-up during the academic year.

Mr. ROEMER. Dr. Williams, what is your funding level for that?

Dr. WILLIAMS. The funding level for that program is about $100 million this fiscal year.

Mr. ROEMER. $100 million?

Dr. WILLIAMS. Right. It's been within the pre-college sector that you find the most rapidly increasing total budget for pre-college, K through 12.

Mr. ROEMER. Do you know how many schools and how many teachers that actually serves?

Dr. WILLIAMS. Yes. I can give you that. Roughly, the numbers are as follows. From fiscal years 1990, 1991 and 1992, the number of teachers who have been directly impacted have increased from about 14,000 to 19,000 to 24,000. Critical to this program is the master teacher concept where one teacher from a school system is excellently trained and then returns to the school during the academic year and assists with his or her colleagues, so there is a multiplier effect.

For this fiscal year, reaching 24,600 teachers, we are directly impacting about 150,000 in programs throughout the country. So the first program is to improve the preparation and competencies in the skills of the teachers, which include, incidentally, acquainting the teachers with the use of the latest educational technologies of the sort that you describe.

The second effort is to deal with the instruction materials, the curricula. We have developed over the last 5 or 6 years a very comprehensive curriculum development program that encompasses the three components of the sector—elementary science, middle school science and mathematics and then high school science and mathematics. An awful lot of these curricula draw very heavily on technology of the sort that you describe, of a host of iterations.

One of the reasons that's been possible is because of a third program we support and that's a program that is devoted to developing educational technology, as well as supporting research that undergirds understanding how students learn science and mathematics and how better to teach those courses. So we've been able to take that knowledge base and feed it into the development of educational technologies or curricula.

Next, there is a program that more specifically deals with provisions for technology into the classroom, supplemental to the regular texts and the curricula that are employed. The last thing that is being done, these four items taken in the aggregate, is we support a rather robust informal science education program that gives opportunities for students to link formal and informal experiences. So, in sum, those are the four efforts.

Mr. ROEMER. Are those all within the Education and Human Resources budget then?

Dr. WILLIAMS. Yes.

Mr. ROEMER. All of those have been going up?

Dr. WILLIAMS. Yes.

Mr. ROEMER. I would like to get more information on that, Dr. Williams. I appreciate that. I have nine universities in my district. Many of them have come to me and said that they would be willing to work with schools in the summertime exposing teachers to the laboratories. I also have a couple of corporations—Miles Laboratories among them—that have volunteered scientists to work with community school teachers to keep them up to date on the latest things and provide a mentor service for them and serve as mentors for students in the community for science fair projects. It is a great cooperative effort and really serves these students well. Thank you, Dr. Williams. It's always good to see you at these hearings.

Let me ask you another quick question too. Dr. Massey, I'd like to ask you a question about this increase in the Antarctic program budget. It's an increase of 75 percent, while our total budget in NSF is going up about 17 percent. As the Chairman talked about, in your outlying years, you have $163 million each year from the NSF. What happened to the money from HUD and DOD in this program? Why is the NSF taking on more and more of the responsibility here? Why isn't there some sharing?

Dr. MASSEY. The increase is an artifact of the way the 1992 base is being funded, the program. As you know, this year for 1992, $105 million—$75 for logistic support and $30 million for environmental, safety and health-related activities—are in the DOD budget. So that money doesn't show in our 1992 base. That's why the increase looks so big.

This year, OMB decided to put that money back into the NSF's budget directly. So really the increase is a very nominal increase in the Antarctic program support. It's just that instead of having the money in DOD this year, we have it in our budget.

Mr. ROEMER. Okay. One final question and it's more a statement than a question. Again, I appreciate Mr. Hayes and the Chairman's time here.

One of the things that I've been talking about, you mentioned in your last comments, Dr. Massey, partnerships. I don't think we do enough of partnerships. There are projects here and there and nobody seems to know what anybody else is doing. I would propose an idea that I've even developed a name for as called CAMERA. It is the Center for Advancing Manufacturing and Education to Rebuild America.

What it would do is take a picture, a snapshot of the future and get us working together for a change on initiatives, especially in our manufacturing areas to retrain workers into new technologies and computer skills, to work on children's educational interests, to get them into internships and apprenticeship programs, much like the Germans have done with the dual track education system, to look at emerging manufacturing areas and, as you talk about, advance manufacturing. I think your word for it was advanced materials. To get those working together in a center somewhere in America, not just in Washington, D.C. where we can see what we need to target in the future for jobs, for the middle class people to get decent jobs, to get a good standard of living, and where we can be competitive in a worldwide global marketplace. I'd sure like to work with you and your staff and Dr. Luther Williams on these kinds of ideas and see what we might develop in the future.

Dr. MASSEY. I hope you don't mind if we steal your title.

Mr. ROEMER. As long as you give me credit for it. Just don't let Jimmy Hayes learn about it. With his bad talk about Notre Dame, I'd never get credit for that.

Mr. BOUCHER. The gentleman from Louisiana, Mr. Hayes.

Mr. HAYES. Thank you.

I can't give Mr. Roemer too much trouble because in the first place, he must have good judgment, and I base that upon knowing his wife. In the second place, my oldest son was educated, his secondary education, in his congressional district, so I can't give him very much trouble at all.

If anything, I'll respond to the comment about where you sit in this room. If there's one room in the Congress where there are no chairs with an aisle, it's Science, Space and Technology with this subcommittee. So the truth of the matter is that I'm not sure we have an established place to sit because most of the time, those of us who serve on this committee and this subcommittee are working towards common goals which I think is something that we not only do not owe an apology to, but perhaps we could educate some presidential candidates about. They might do much better in primaries if they put that part aside and started a conversation about the next generation of kids.

With that in mind, Dr. Massey, I don't know how familiar you are with sports because if you know about Notre Dame then I'm talking about amateur sports.

[Laughter.]

Mr. HAYES. There's a term in softball about serving up marshmallows. I really came over with the intent to serve some up because whether you are aware or not, when you come from a State like mine, Louisiana, where every time there's an assessment of the educational system, we're right near the bottom. When you have people who want their kids to have the best educational system and realize that they are probably one of the worst, it is gratifying that you are in charge of an important National Science Foundation that has recognized that there are programs of merit in our State.

I wonder if you know how much hope you give to how many parents by giving them an opportunity to participate and secondly, by that designation, telling them that if you work hard at it, then there is going to be a conduit in which you can turn that into success.

So the only things I want to put on the record—and I'll tell you without any reason to be embarrassed—I want them there so I can repeat them later as coming from you and talking about our State.

We're very proud that we were one of the eight States to get the statewide systemic change award and if you could just take a minute, I know it's part of your statement, just to elaborate a bit of the program and what you can hope to accomplish in States like mine with the implementation of the program, I'd appreciate it very much.

Dr. MASSEY. Sure. This program, we feel, is one of the most revolutionary that we have mounted at the Foundation. The goal here is to have a partnership—there's that word again—between the Foundation and the State to put together a strategic vision plan for the entire State. Part of that has to be that the State itself has to have undergone that planning process in order to identify what its goals and priorities are to bring together all the important players in the process—goes to boards, the Governor's office, and private industry.

One of the things we have found that this process has initiated is that it's causing the States to look internally, to assess where they are and where they want to be, and to put together a plan because the amount of money that we give, even though it's large by our standards—$1.5 to $2 million a year—is small by State budgets. The money is leveraged tremendously because the State then is able to use the NSF expertise and resources and imprimatur in order to bring about changes in the State. I've been very pleased as I've looked at what kind of planning the States have undergone to put together these programs.

The hard part is going to be implementing but I think that we are very pleased by the effort that has gone into putting these programs together.

Mr. HAYES. Also, the competitive research—Louisiana actually has to its credit, former Congresswoman Lindy Boggs—became, at her suggestion, a very active participant in the NSF Experimental Program on Stimulating Competitive Research. We got one of your NSF Advanced Development Program Grants. Would you mind doing the same and outlining the potential benefits under that grant program?

Dr. MASSEY. They are somewhat similar to SSI concept but not in kind. SSI is connected with education and human resources. The program was put together in order to provide States which have not been competitive in our normal grants process to build a research base from which they could begin to submit competitive proposals. I think it was an excellent idea and a tribute to Congresswoman Boggs and others and also it recognized that the NSF is a competitive agency based on peer review. Instead of the States going around the peer review system, they said, show us how to become part of the system. So we are very pleased with that and Louisiana has been disciplined in that.

I think an example of the degree to which that State has progressed is the fact that you have been chosen as the site for perhaps the most advanced research facility in the world, the Laser Interferometer Gravitational Observatory.

Mr. HAYES. The next point I wanted to make was in preparing, having some of these statements made, I noticed that originally the ADP grants were to be about $1.5 million per year. I know that you suffered from budgetary constraints and that actual awards were at a high $1.3 million and that some were less. What I'm offering to do here now is to ask the question and give you the opportunity to comment. In this world of budget constraints, would you not consider a priority of having Congress provide additional funds for the program in order to, at a minimum, meet the original $1.5 million target, and at a maximum, improve that dramatically under priorities of what ought to be contained within the budget process?

Dr. MASSEY. I would not want to do that by changing our budget. That happened in 1992. Congress did give us additional funds. I think we go through a very elaborate internal planning process to set the priorities, and as you say, we have to fit them within the constrained budget. I really feel that the budget we have before you is our best budget.

Mr. HAYES. Finally, our State, and I'm very proud of this, Louisiana itself has suffered in the past from an abundance of resources. That may sound like a silly statement but when I graduated from high school in 1964, the kids that were in my graduating class would go offshore and roughneck at $30,000 a year. Imagine what kind of income that meant in 1964. And they were jobs that were going to last forever. Because of that, we lose and lost an incredible number of bright and talented people to terminating their education at the end of their senior year.

Now, they are my age, 45 years old. Those companies have cut back. Rig count is at an all-time low, and they're suddenly looking at their own children and saying, I wish that I had it to do over again, not so much for myself as for you, because we've left you with very few opportunities and not the realization of the importance of education.

For that reason, I'm especially proud that in our State—we have a Louisiana Educational Quality Support Fund which is a trust fund created with oil and gas revenues dedicated to it. What we are trying to do is limit that to education, including elementary-secondary education, but all fields of educational endeavor. We're trying to do the systemic reforms in our system that you were talking about at the national level.

My request is, if you could make a comment on the record, can you outline for me any way that we might work with NSF or NSF can work with us, more closely with Louisiana, to help achieve these mutual goals of trying to make up for what has now been decades of, if not indifference, nonrealization of the importance of educational goals?

Dr. MASSEY. Well, I think that's exactly what we are trying to do with all our programs. That's why I emphasize partnerships, working with the States to try to identify priorities at the State level because they may differ from State to State, where our programs can fit in with the goals of the State.

You mentioned the SSI, that's one. EPSCOR is another. The programs we will have now in more of the community colleges and is probably going to be the kind of thing Louisiana would see as a high priority for the group of people who may be in a transition stage from high school to going on to a higher education. Our program, Alliance for Minority Participation—Louisiana has a high minority population—I think would also fit those goals, to bring those groups forth into the educational process.

In all of our efforts, the one thing we are really trying to do is form a relationship with the States. As I've been going around visiting, I make it a point each place to try to get a private audience with the Governor of that State to express that we want to work through a partnership, and I want us to be on a face to face, personal basis, so that when there is a problem, the Governor can call me.

I look forward to establishing that in Louisiana. I haven't been there yet, but I will be there. We're going to dedicate our Antarctic vessel some time later this month.

Mr. HAYES. Mr. Chairman, thank you very much, and I appreciate the time. Also, I am really sorry Mr. Roemer left because I cannot close without mentioning that it's not my fault that he's not here to have this on the record, but so many friends of mine participated in 1969-70 when Louisiana State University played Notre Dame, the difference being that almost all of my friends were Catholic, whereas most of his team wasn't.

[Laughter.]

Mr. BOUCHER. The Chair thanks the gentleman for his enlightening and entertaining round of questions on whichever side of the aisle he chooses to sit.

Dr. Massey, just a couple of housekeeping details. First of all, returning to the Statewide Systemic Initiative for Math and Science Education, I note that you have two staff people at the present time who are supervising the ten grant awards that you've presently made. My understanding is that you're planning now to increase the scope of that program potentially to as many as 25 grant awards, so you'll more than double that number. Can two staff people administer a program of that scope. Would you need more resources, and, if you do need more, have you budgeted for that and has the Administration accommodated your needs?

Dr. MASSEY. We do need more. That's in our budget plan. That's also been addressed through parts of the reorganization effort that Dr. Williams has in place. So if we receive our budget request for S&E this year throughout the program, we should be able to put into place the management structure.

Mr. BOUCHER. So your needs are met in the Administration's budget request?

Dr. MASSEY. Yes.

Mr. BOUCHER. Several of my colleagues who have had the good fortune to accompany the National Science Foundation on a visit to your research activities in Antarctica had commented to me on the nature of the airplanes that you have as a part of the program there. In fact, they seem to be somewhat antiquated, and I noticed some chuckles in the audience. I may have understated the case.

What are your plans for refurbishing your fleet of airplanes and are those needs accommodated in the Administrations budget?

Dr. MASSEY. Not fully and there is some uncertainty. However, Dr. Wilkniss is here.

Mr. BOUCHER. Dr. Wilkniss, we'll be happy to hear from you, sir.

Dr. WILKNISS. Mr. Chairman, the National Science Foundation owns seven LC-130 aircraft that are ski-equipped. Three of those were built in 1960 and four of those in the 1970s. The Congress has appropriated funds for an extensive rehabilitation program consisting of two parts. Three of the old airplanes are structurally upgraded to come up to the carrying capacity and extend their service life compared to the ones that were built in the 1970s, and all seven of the aircraft are now in the process of receiving new avionics. That is they are going from vacuum type tube radios in the aircraft, to the modern solid state aircraft. The program will be completed in 1995 at a total cost of $43 million.

At the same time, the Congress has put into the DOD appropriation for 1992 two new LC-130 aircraft to be given to the Air National Guard of the State of New York, and the Congress has directed that two of the existing LC-130 aircraft that were built in 1985 be then given to the U.S. Antarctic program.

So we extend the service life of the existing aircraft, and we would receive two relatively new aircraft in the 1995 calendar year if DOD goes ahead. Extensive questions need to be worked out between DOD and the Congress as to the final disposition of this year's appropriation.

Mr. BOUCHER. Assuming that the appropriation is made as anticipated, will this satisfy the needs that the NSF has for aircraft in Antarctica or do your need go beyond that?

Dr. WILKNISS. That will get us back to our plan, Mr. Chairman, that requires to replace the oldest aircraft and all the NSF aircraft over a period of the year 2001 to 2004 with the beginning of the appropriation of funds for new NSF aircraft beginning in fiscal year 1996.

Mr. BOUCHER. So I gather you're going to be satisfied, assuming that the appropriations process works its way to completion?

Dr. WILKNISS. That is correct, Mr. Chairman.

Mr. BOUCHER. I'll look forward to working with you later in this year as we implement the provisions for the new Antarctic Treaty, and we'll have additional discussions on that somewhat later. Dr. Wilkniss, thank you, sir.

I have one other question, and this is directed to the NSF by the Chairman of the full committee who has a special interest in your Earthquake Hazards Reduction Program. He's concerned about the funding level for that program generally within the NSF. I have a number of statistics here but the sum total of it is that, while you have had a rather significant increase in funding within your Engineering Directorate and also within your Geosciences Directorate, the two directorates that fund earthquake activities within the NSF, the actual constant dollar funding for those earthquake activities, both for engineering and also for earthquake sciences, has decreased. The total decrease is on the order of 17 percent from fiscal year 1985 to fiscal year 1993.

The question is simply stated this way. Why the decrease? Why have you chosen to do that, and what effect has this decrease in constant dollar terms had on your earthquake programs?

Dr. MASSEY. I can submit that in detail, but we've looked at this because those questions came up in our appropriations hearings also. In terms of the program that is now being developed for the Earthquake Centers, that funding seemed to be appropriate in terms of the other priorities we have in the area. We have longer justifications, but it's something we have paid attention to because we receive questions about it. I'd prefer, if you don't mind, to submit that.

Mr. BOUCHER. We would be pleased to receive the written response to that question. In fact, I'll provide the question in somewhat greater detail in writing to you so that you'll have a greater basis on which to respond.

Dr. MASSEY. Thank you.

Mr. BOUCHER. That concludes the Chair's questions, Dr. Massey. I'd be pleased to recognize the gentleman from New York.

Mr. BOEHLERT. Dr. Massey, can you tell me a little bit about the high performance corridor at the NSF?

Dr. MASSEY. Dr. Habermann is head of our Computer and Information Sciences Directorate. I don't know that particular term. Have you, Chuck? Dr. Brownstein was formerly head of the area responsible for that.

Dr. BROWNSTEIN. I've heard that term used before in the context of interaction between the Cornell Supercomputer Center and Syracuse University.

Mr. BOEHLERT. You're right on target.

Dr. BROWNSTEIN. That's something which we've followed closely. You know we have supported Cornell over the years and continue to support it as one of the NSF Supercomputer Centers. The other institution which recently started a supercomputing program, and they are a very active partner in the Science Technology Research Center which is nominally called Rice/Caltech, but also includes the station of Syracuse.

They have had plans at one time or another for a more extensive interaction between the two institutions and will be pursuing them as far as I know under the new funds being made available from the supercomputing program, not just from NSF but from NASA, DOE and DARPA as well.

Mr. BOEHLERT. At what stage do you think they are right now? As the crow flies, the two universities are 35 or 40 miles apart. Do you know?

Dr. BROWNSTEIN. Well, they are both key parts of the NSFNET which serves all the researchers who participate in the high performance computing initiative and under other things. I think they have plans for expanding their communications and making it an attractive place to industry locally and to other institutions locally. I know that's been talked about; I don't know of specific proposals or their disposition other than the fact that they have been encouraged to explore the opportunities under the initiative.

Mr. BOEHLERT. That's the type of initiative we look forward to working with.

Dr. BROWNSTEIN. That's the kind of thing that the high performance computing initiative is meant to be responsive to, yes.

Mr. BOEHLERT. So we've got to do a little more homework to be competitive.

Dr. BROWNSTEIN. One needs also to keep in mind that both of those institutions have been very successful in obtaining funds from NSF and other parts of the Government.

Mr. BOEHLERT. Success breeds success.

Dr. BROWNSTEIN. Absolutely.

Mr. BOEHLERT. Thank you very much.

Thank you, Mr. Chairman.

Mr. BOUCHER. The Chair thanks the gentleman and expresses the thanks of the subcommittee to Dr. Massey, Dr. Bernthal, and other NSF personnel who joined us here today. I'll be sending a letter to you, Dr. Massey, that contains three or four items of inquiry that we did not cover today and more specifically ask the question with regard to your earthquake programs. We would appreciate your written response.

[The prepared statement of Mr. Costello follows:]

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ENERGY RESEARCH AND DEVELOPMENT
SCIENCE RESEARCH AND TECHNOLOGY

SELECT COMMITTEE ON AGING

STATEMENT BY U.S. REPRESENTATIVE JERRY F. COSTELLO (D-IL)

SCIENCE, SPACE, AND TECHNOLOGY SUBCOMMITTEE ON SCIENCE

"OVERSIGHT OF THE NATIONAL SCIENCE FOUNDATION"

MARCH 3, 1992

MR. CHAIRMAN, THANK YOU FOR CALLING THIS OVERSIGHT HEARING. I AM PLEASED TO BE HERE TODAY AS WE REVIEW THE PROPOSED FY 1993 BUDGET FOR THE NATIONAL SCIENCE FOUNDATION. I WOULD LIKE TO TAKE THIS OPPORTUNITY TO WELCOME OUR WITNESSES. I AM ANXIOUS TO HEAR THEIR TESTIMONY. I WOULD ALSO LIKE TO COMMENT THAT I AM PLEASED THAT THIS COMMITTEE AND THE NSF HAVE ENJOYED A STRONG HISTORY TOGETHER AND I LOOK FORWARD TO WORKING CLOSELY WITH DR. MASSEY AND THE NSF IN THE FUTURE.

AS WE KNOW, NSF BUILDS U.S. SCIENTIFIC STRENGTH BY FUNDING RESEARCH AND EDUCATION ACTIVITIES IN ALL FIELDS OF SCIENCE AND ENGINEERING AT COLLEGES AND UNIVERSITIES AND OTHER RESEARCH INSTITUTIONS THROUGHOUT THE UNITED STATES. THE NSF BUDGET FOR FY 92 COMPRISED ONLY ABOUT THREE PERCENT OF THE FEDERAL R&D BUDGET, YET NSF PROVIDES ABOUT 25% OF BASIC RESEARCH FUNDING AT UNIVERSITIES AND OVER 50% OF THE FEDERAL FUNDING FOR BASIC SCIENCE RESEARCH.

I AM VERY INTERESTED TO HEAR TODAY THE THOUGHTS OF DR. MASSEY

AND DR. DUDERSTADT REGARDING BUDGET PROPOSALS FOR FY 93. I AM ALSO INTERESTED IN AN OVERVIEW OF PROGRAMS AND ACTIVITIES OF NSF.

AGAIN, I WELCOME OUR WITNESSES, AND THANK YOU, MR. CHAIRMAN FOR CALLING THIS HEARING AND FOR YOUR CONTINUED LEADERSHIP OF THIS SUBCOMMITTEE.

Mr. BOUCHER. Thank you very much for your attendance today.

[Whereupon, at 3:12 p.m., the subcommittee adjourned, to reconvene at the call of the Chair.]

APPENDIX

U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

SUITE 2320 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515-6301
(202) 225-6371

March 4, 1992

Dr. Walter E. Massey, Director
National Science Foundation
1800 G Street, N.W.
Washington, D.C. 20550

Dear Dr. Massey:

Thank you for your informative testimony before the Science Subcommittee on March 3, 1992 concerning the National Science Foundation (NSF) budget request and program plans for fiscal year 1993. In order to complete the hearing record, we request your responses to the following additional questions:

1. What was the level of NSF's initial budget request to OMB for each of the major NSF budget categories? What was the initial request for the Academic Research Facilities Modernization Program?

2. How do the EPSCoR, the Statewide Systemic Initiative, and the Alliances for Minority Participation programs at NSF relate to the interagency program of the FCCSET Committee on Education and Human Resources to improve math and science education?

3. How do you view the future of the EPSCoR program at NSF?

4. What do you think of efforts to transplant the NSF model for EPSCoR to other federal agencies like DoE, DoD, EPA, NASA, and the NIH?

5. The National Earthquake Hazards Reduction Program (NEHRP) has not participated in the recent budget growth at NSF. Total funding for the NEHRP has declined by 17% in constant dollars from FY 1985 to the requested level for FY 1993.

   (a) What is the rationale for the low priority NSF has assigned to the NEHRP and was any consideration given to the intent of Congress (P.L. 101-614) in deciding on the funding priority?

   (b) What has been the trend in numbers of proposals received and funded, in numbers of researchers supported, and in the size of research grants in the NEHRP from FY 1985 to the present?

Dr. Walter E. Massey
March 4, 1992
page 2

6. Under the proposed reorganization of the Education and Human Resources (EHR) Directorate, informal science education activities appear to have been deemphasized; the title, "Informal Science Education", is dropped from all division and program titles in the budget document.

   (a) Is there a plan to deemphasize or otherwise reduce resources available for informal science education activities?

   (b) What is the amount budgeted for informal science education activities in the FY 1993 budget?

7. Should the FY 1993 NSF request for Salaries and Expenses be approved, what staffing levels will be provided for the new Research, Evaluation and Dissemination activity in EHR and for the Statewide Systemic Initiative program? Indicate the number of permanent staff positions and number of rotators, and indicate how many staff will be assigned to program evaluation activities.

8. NSF has several major facilities construction projects simultaneously underway: LIGO, two optical telescopes, and the high-magnetic field lab.

   (a) Is there a formal process at NSF by which large national facilities construction projects are assessed and prioritized as a group? Does the National Science Board consider each large construction project in isolation from others being proposed?

   (b) What are the principal criteria applied in the selection of large facilities construction projects?

I appreciate your attention to this request. Your reply will be included in the printed hearing record.

With kind personal regards and best wishes, I remain

Sincerely,

Rick Boucher, Chairman
Subcommittee on Science

RB/Wns

NATIONAL SCIENCE FOUNDATION
1800 G STREET, N.W.
WASHINGTON, D.C. 20550

nsf

OFFICE OF THE
DIRECTOR

April 8, 1992

Honorable Rick Boucher
Chairman
Subcommittee on Science
Committee on Science, Space,
and Technology
U.S. House of Representatives
Washington, DC 20515

Dear Mr. Boucher:

Thank you for your letter of March 4, 1992, regarding your interest in the National Science Foundation's budget request and program plans for fiscal year 1993. I was most pleased by the Committee's attention to the Foundation during the recent hearing. I am pleased to present the Foundation's responses to your questions regarding specific NSF programs.

I look forward to working with you in the future and will be happy to supply any further information you or members of your committee might require.

Sincerely,

Walter E. Massey
Director

Enclosure: Questions/Answers for the Record from
Congressman Rick Boucher

QUESTIONS FROM CONGRESSMAN BOUCHER

1. What was the level of NSF's initial budget request to OMB for each of the major NSF budget categories? What was the initial request for the Academic Research Facilities Modernization Program?

ANSWER: The National Science Foundation (NSF) OMB Budget Request for FY 1993 was $3.07 billion. The total includes the following appropriations:

(Millions of Dollars)

Account	FY 1993 Request
Research and Related Activities	$2,244.2
Education and Human Resources	434.0
United States Antarctic Program	
Research Activities	106.9
Logistics Support	105.0
Academic Research Infrastructure*	50.0
Salaries and Expenses	126.0
Office of Inspector General	4.0
Total, NSF	$3,070.1

* FY 1993 Academic Research Facilities Modernization Program was combined with the Academic Research Instrumentation Program into the common program of Academic Research Infrastructure in order to receive broad support from the disciplinary and institutional communities.

2. How do the EPSCoR, the Statewide Systemic Initiative (SSI), and the Alliances for Minority Participation (AMP) Programs at NSF relate to the interagency program of the FCCSET Committee on Education and Human Resources (CEHR) to improve math and science education?

ANSWER: The objectives of the CEHR program for math and science education include (1) Improved performance of U.S. students; (2) development of a strong precollege teacher workforce; and, (3) assurance of an adequate pipeline for the science and technology workforce, including increased participation of underrepresented groups.

The CEHR precollege strategy is predicated on the critical and mutually reinforcing roles played by teacher enhancement and preparation, curriculum reform, and systemic reform programs in achieving these objectives. The SSI Program is the most far-reaching Federal effort supporting math and science reform at the precollege level, representing nearly 75% of requested funding for reform programs in the FY 1993 CEHR budget request. The SSI Program establishes alliances between NSF and all State players that affect education policy, legislation, resources, and practices. It promotes activities that strengthen all major aspects of a State's educational system.

The AMP Program is part of a comprehensive NSF strategy to improve the quality of education received by minorities and significantly increase their participation in scientific and technical fields. As with SSI, these programs forge alliances between NSF and the broad education community. AMP represents nearly 45% of the FY 1993 CEHR budget request for undergraduate operational reform programs. Related NSF activities include Research Careers for Minority Scholars (RCMS) Programs at the undergraduate level and the Career Access Program (regional centers, and district-based partnerships) at the precollege level.

The NSF Experimental Program to Stimulate Competitive Research (EPSCoR) was developed as a program to improve the scientific and technological capacity of states with less developed research infrastructure. EPSCoR has not been included in the NSF CEHR budget estimates because its emphasis is on improving research activities within states.

3. How do you view the future of the EPSCoR program at NSF?

ANSWER: The EPSCoR program has been functioning extremely well and we view the recent relocation of the program to the Education and Human Resources Directorate (EHR) as a positive move that will help to ensure its continued success. The programs within the EHR Directorate are currently developing strategic long-range plans that will allow them to better meet National goals in science and mathematics education. The EPSCoR program is very much a part of this process.

4. What do you think of efforts to transplant the NSF model for EPSCoR to other agencies like DoE, DoD, NASA, and NIH?

ANSWER: The EPSCoR program has demonstrated success by enhancing academic research competitiveness and developing state science and engineering infrastructure.

While NSF is not in a position to comment on the effectiveness of EPSCoR in other agencies, the Foundation has been working informally, at the program officer level, with those agencies where EPSCoR-like programs have been established. EPSCoR program officers are cooperating, on a regular basis, with their counterparts in other agencies to exchange information and coordinate program management details.

5. The National Earthquake Hazards Reduction Program (NEHRP) has not participated in the recent budget growth at NSF. Total funding for the NEHRP has declined by 17% in constant dollars from FY 1985 to the requested level for FY 1993.

(a) What is the rationale for the low priority NSF has assigned to the NEHRP and was any consideration given to the intent of Congress (P.L. 101-614) in deciding on the funding priority?

ANSWER: NSF considers its role in NEHRP to be vital to the success of the overall earthquake program. While the budget for the earthquake engineering portion remained fairly stable for several years, it was increased from $15.22 million in FY 91 to $16.70 million in FY 92. A slightly smaller increase is in the President's FY 93 budget request. Within NSF, then, earthquake engineering is not viewed as having low priority but rather reflects a shift in emphasis within the NSF-NEHRP toward engineering studies and implementation.

NSF has also been able to leverage its funds by supporting the National Center for Earthquake Research at the State University of New York at Buffalo. The Center was established in 1986 with a $5 million per year grant from NSF with a matching fund requirement. This matching fund requirement has meant that millions of additional dollars have been made available, mainly from the State of New York, to researchers in the earthquake engineering community.

NSF is currently exploring ways to link earthquake engineering research with other important areas that are vital to the economic well-being and quality of life in the nation. The Directorate for Geosciences supports the Fundamental Earthquake Studies component of the NEHRP with emphasis toward engineering studies and implementation. The Engineering Directorate is concerned about civil infrastructure systems and providing a knowledge base for improving the decaying infrastructure throughout the United States. The role of the earthquake engineering activity would be to link seismic safety with such improvements.

(b) What has been the trend in numbers of proposals received and funded, in numbers of researchers supported, and in the size of research grants in the NEHRP from FY 1985 to the present?

ANSWER: Since 1985, there has been an increasing number of proposals received in the earthquake engineering program. The number of investigators supported and the size of the grants have remained about the same.

There is always a major increase in proposals received by NSF in any single year in which a damaging earthquake has occurred, such as following the 1989 Loma Prieta earthquake. In FY 91, a more typical year the program considered 327 applications and made 170 awards, including continuing and supplemental awards. This is well above the average funding rate for NSF programs. Over the years the typical new award has been for $90,000 a year in support of two investigators.

The NSF-funded National Center for Earthquake Engineering Research has organized a coordinated set of research and related activities. In addition to SUNY-Buffalo, the core institutions involved in this effort include Cornell, Rensselaer Polytechnic Institute, Princeton and Columbia Universities. Over forty investigators at these and other institutions participate in the Center's coordinated research activities. This number has remained fairly constant during the six years of the Center's existence.

6. Under the proposed reorganization of the Education and Human Resources (EHR) Directorate, informal science education activities appear to have been deemphasized; the title, "Informal Science Education", is dropped from all division and program titles in the budget document.

(a) Is there a plan to deemphasize or otherwise reduce resources available for informal science education activities?

ANSWER: EHR does not plan to deemphasize informal science education or reduce resources for informal science education activities. Our commitment to this area has not changed. We have elected to re-establish a program element for Informal Science Education. The program will be one of four programs in the Division of Elementary, Secondary and Informal Education.

(b) What is the amount budgeted for informal science education activities in the FY 1993 budget?

ANSWER: The request for FY 1993 for this program is $35 million. This money will be used to enhance science education in the informal sector, to strengthen the connection between informal and formal education, and to improve the public's understanding of and support for science. The program will continue to support museums, science centers, broadcast media, youth-based organizations, and other organizations that can provide quality programs in science education for young people and adults.

7. Should the FY 1993 NSF request for Salaries and Expenses be approved, what staffing levels will be provided for the new Research, Evaluation and Dissemination activity in EHR and for the Statewide Systemic Initiative program? Indicate the number of permanent staff positions and number of rotators, and indicate how many staff will be assigned to program evaluation activities.

ANSWER: In the Office of Studies, Evaluation, and Dissemination, there are currently six professional staff (not counting the Division Director), one new additional staff person has been recruited. As part of the reorganization, the Division of Research, Evaluation and Dissemination will gain four additional professional staff (3 are permanent) who are currently assigned to the Applications of Advanced Technology program and Research in Teaching and Learning program.

The Statewide Systemic Initiatives (SSI) program currently has four people. All are rotators. In addition, staff from throughout the Directorate have participated in the conduct of panel meetings, site visits, and contract proposal reviews. To assist the program officers in dealing with the day to day matters of management and oversight, the Directorate will be awarding a contract in the very near future to provide technical assistance to the States, some project monitoring, and program evaluation.

At the FY 1993 full Salaries and Expenses request level, we would be able to make additions to these functions. While we cannot commit to a specific number at this time, since we would have to evaluate our needs at the time, SSI and Research, Evaluation, and Dissemination would have a very high priority within EHR.

8. NSF has several major facilities construction projects simultaneously underway: LIGO, two optical telescopes, and the high-magnetic field lab.

   a) Is there a formal process at NSF by which large national facilities construction projects are assessed and prioritized as a group? Does the National Science Board consider each large construction project in isolation from others being proposed?

ANSWER: Each division through the use of staff and advisory committees assigns priorities to facilities important to its discipline. A similar process is used at the directorate level. As each years budget is constructed the Director and his staff assess the requests from the directorates and decide on the priorities for the Foundation as a whole.

As plans for large projects are being developed presentations are made to the National Science Board (NSB). The NSB discussed the LIGO project several times before the proposal to begin actual construction came before the Board. Although the NSB considers construction projects one at a time, they do so with the knowledge of what other facilities are operating, under construction, or planned.

Periodically the NSB reviews the major programmatic activities the Foundation is involved in to assess overall levels of capital needs and maintenance and operations.

b) What are the principal criteria applied in the selection of large facilities construction projects?

Answer: The general criteria are scientific quality and the opportunities to advance knowledge as well as the availability of funding and the impact on the overall budget. Each large project undergoes rigorous assessment by the community as to the importance of the research to be performed and the likelihood the facility will provide definitive answers. When two or more facility projects in disparate fields are competing for limited funds, judgements are made as to the relative importance of the fields of inquiry and the usefulness of the expected results.

NATIONAL SCIENCE FOUNDATION
1800 G STREET, N.W.
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OFFICE OF THE
DIRECTOR

Honorable George Brown
Chairman
Committee on Science, Space,
and Technology
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

As you know, the FY 1988 Authorization Act includes a provision that requires the Foundation to submit to Congress, along with the annual budget request, a three-year budget estimate which includes estimates for each major activity, including each scientific directorate, the Education and Human Resources Activity, the United States Antarctic Program, Academic Research Facilities and Instrumentation, Salaries and Expenses, and the Office of Inspector General. Estimates for Fiscal Years 1993, 1994, and 1995 are attached to this letter.

The budget request for FY 1993 reflects the Administration's commitment to double the NSF budget. The estimates for FY 1994 and 1995 reflect a government-wide policy to show nominal freezes in budget authority between 1993-1997. In subsequent years, each candidate for increased funding will be considered on its merits, and decisions made accordingly. Even so, we fully expect the President's strong commitment for science and research and development to continue.

In light of this policy, estimates for FY 1994 and FY 1995 are difficult to make at this time. I would, therefore, like to use this letter to provide the Committee with a sense of my concerns and priorities for the Foundation that will guide us over the next few years.

Having clearly articulated goals and priorities is essential. That is why I have recently issued a statement of my beliefs in this regard (attached); my highest priority is to maintain and enhance the health and vitality of our nation's research and education enterprise, including building bridges between academia and industry.

Against this back-drop, the National Science Board and I, working with the Foundation's staff, are undertaking a new long-range planning exercise for FY 1994 - 1998. We will be seeking advice and information from the entire spectrum of the research and education enterprise - from individuals, the professional societies and associations, advisory committees, industry leaders, etc. This will be a "bottoms-up" approach that will assess needs, plan future directions, and recommend outcome measurements. The National Science Board will discuss the Foundation's long-range plan at its June meeting. Once completed, we intend to carefully consider the results of this process and its implications for the future. Let me emphasize, however, that this plan will not be static - it must be vital and subject to adjustment to reflect future opportunities as yet unforeseen.

Nevertheless, even though our planning has just begun, certain themes have already emerged that will influence the development of our long range plan.

I fully expect that the interagency initiatives derived from the Federal Coordinating Council on Science, Engineering and Technology (FCCSET) process will continue to develop. These initiatives are critically important to our Nation's economic growth, technological development, and international competitiveness and they provide important coordination with other Federal agencies and programs. We are an active participant in that process. But, as FCCSET initiatives like High Performance Computing and Communications, Advanced Materials and Processing, and Biotechnology Research increasingly help to shape and mold the NSF budget, so too must the disciplinary research areas such as biological, computer and engineering sciences, mathematics, and the physical sciences enjoy growth to be able to accommodate such initiatives and generate new knowledge.

Science and engineering research constantly evolves, and through this process new opportunities and initiatives develop; therefore, we must be ready to respond to opportunities as they arise if we are going to meet our responsibility to maintain the health of the nation's research enterprise. For example, our FY 1993 budget request reflects the importance we assign to advanced manufacturing research and multidisciplinary research on the environment. Manufacturing research profoundly impacts our ability to compete in today's global economy, while environmental research reflects our growing awareness of the need to live in greater harmony with our natural resources.

The Nation's infrastructure requires attention, and this is no less so for the science and engineering infrastructure of the country. Our intellectual and physical infrastructure are the foundation upon which we train the Nation's future S&E workforce. That foundation must be secure, and NSF has a major role to play in this area. Education and training must take place in a conducive setting with the right tools; and all our citizens should be literate in S&E. The infrastructure impacts the future education of our grade-school students and the training of our graduate students and post-docs. The curriculum must be appropriate on the one hand, and the tools must be available on the other.

It is evident that all areas of the Foundation will be affected by the results of this planning process. It will probably also affect the way we do business and thereby our administrative resource requirements. Current and emerging priorities, within the budget environment, will certainly emphasize some areas more than others in ways that are difficult to state at this time.

In this letter I have attempted to give you a sense of the priorities and pressures as we see them at this time and the importance I place on the continued development of a balanced set of priorities for the future. I look forward to discussing our FY 1993 Budget Request and all of these issues with the Committee in the upcoming weeks.

Sincerely,

Walter E. Massey
Director

Enclosures:
1. Estimates for FY 1993, 1994, and 1995
2. Statement of Goals and Priorities

Attachment 1

OUTYEAR PROJECTIONS OF NSF BUDGET
BASED ON PRESIDENTIAL POLICY
(Dollars in Millions)

05-Feb-92

	FY 1993	FY 1994	FY 1995
Biological Sciences	$320.6	$320.6	$320.6
Computer and Information Science and Engineering	272.2	272.2	272.2
Engineering	312.5	312.5	312.5
Geosciences	472.4	472.4	472.4
Mathematical and Physical Sciences	726.0	726.0	726.0
Social, Behavioral and Economic Sciences	107.8	107.8	107.8
Total, Research and Related Activities	$2,211.5	$2,211.5	$2,211.5
Education and Human Resources	479.5	479.5	479.5
United States Antarctic Program	163.0	163.0	163.0
Academic Research Facilities and Instrumentation	33.0	33.0	33.0
Critical Technologies Institute	1.0	1.0	1.0
Salaries and Expenses	135.0	135.0	135.0
Office of Inspector General	4.0	4.0	4.0
Total, National Science Foundation	$3,027.0	$3,027.0	$3,027.0

Attachment 2

NATIONAL SCIENCE FOUNDATION
OFFICE OF THE DIRECTOR
WASHINGTON, D.C. 20550

STAFF MEMORANDUM

December 6, 1991

O/D 91 - 31

TO: ALL STAFF

FROM: DIRECTOR

STATEMENT OF GOALS AND PRIORITIES

The National Science Foundation is uniquely positioned to contribute to the health and welfare of the nation through the creation and dissemination of knowledge resulting from our support for research and education. The public rightly expects much from us; therefore, it is particularly important that we fulfill our responsibilities as an agency capably and thoughtfully.

As we implement our present programs, and begin to plan for the future, we face new and dynamic scientific and societal challenges. I want to share with you my personal goals and priorities so that we can work together to meet them in the most effective way.

PRIORITIES

The National Science Foundation enjoys an abundance of talent among our staff and considerable resources have been entrusted to us by the public. **My highest priority is to use these resources to maintain and enhance the health and vitality of our nation's research and education enterprise.** This includes building stronger bridges between academia and industry in order that the excellence of our academic institutions contributes substantially to the standard of living of all members of our society.

Since education and research are inseparable, this priority also includes the promotion of excellence in science, engineering, mathematics and technology education at all levels. It is crucial that the Foundation continue its leadership role in increasing the development and representation of all citizens, particularly currently underrepresented groups, in all aspects of the research and education enterprise.

GOALS

Unity of purpose and clear goals are essential to our performing well as an organization despite constrained resources, increased responsibilities, and a growing workload. **Unity requires** that we view ourselves foremost as staff of NSF whose first duty extends beyond individual programs and organizations to the Foundation as a whole. **This should be the guiding principle** in our interactions with each other, with our constituent communities and with the public. **Clear goals** and directions are essential to manage responsibly the resources entrusted to us by the public.

First, I am committed to increasing support to individual investigators through budget allocations and larger grant size and extended award duration. To meet new needs in selected areas of research and education, I will continue to strive for balanced support for alternate modes of funding research, such as groups, centers, and major facilities.

Second, NSF must be responsive to current critical national needs, particularly in education and in human resources and economic development. Foundation programs in all directorates should focus on educating our citizenry to meet current and future requirements for scientific and technical personnel, and on promoting retention of human resources throughout the education and research enterprise.

Third, I am committed to having the Foundation's staff, our management practices and all our activities reflect and exemplify the excellence we strive for through our external mission. We must ensure an environment that encourages our staff to contribute their talent to our enterprise and to have confidence in NSF as a fair, conscientious and respectful employer. We will take special care to see that this extends to under-represented groups. **Management and supervision throughout the Foundation must reflect the fact that our people are our most important resource.**

IMPLEMENTATION

We will establish the means to measure the output and effectiveness of our programs both to inform our long range planning and to guide our program development. Just as we will put increased emphasis on evaluation of the effectiveness of our external programs, we will also focus on our internal activities.

The recent reorganization has improved the structure to meet new research and management needs. I have charged the Assistant Directors, Office Directors, and staff in the Office of the Director with responsibility to review and improve our operations. I have charged them to work with me, the Deputy Director, and with all staff to improve processes of internal communications and to encourage the fullest use of the inherent and rich diversity within our organization.

I will work with senior management, including Division Directors, to ensure that our management structure accomplishes the work of the Foundation and serves the needs of the staff. Managers and supervisors at all levels will be held accountable for the quality of their management and supervision. **Accountability as well as reward for excellence must be integral to our work.**

The implementation of these goals and priorities will require strong commitment from the entire Foundation. The excellence of our staff is an invaluable asset and I encourage everyone to make this commitment, and to participate in determining the most effective means to achieve these goals.

I will continue to meet personally with staff in a variety of settings to discuss these issues and other matters of importance to the Foundation. In the near future, I will convene a meeting of all staff to discuss these goals, our planning process, the new organization structure, and other issues staff members are interested in raising.

Walter E. Massey

U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

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WASHINGTON, DC 20515
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August 1, 1991

Dr. Walter E. Massey, Director
National Science Foundation
1800 G Street NW
Washington, DC 20550

Dear Dr. Massey:

The Subcommittee on Science requests that the National Science Foundation provide an update on the activities of the Foundation in support of major research facilities. We request information both on existing facilities and also on new facilities which have been approved for construction.

The astonomy survey report of the National Research Council released this year, "The Decade of Discovery in Astronomy, and Astrophysics", calls particular attention to the deterioration of ground based astronomy facilities. As highlighted in a recent article in Science, inadequate maintenance evidently has resulted in the loss of scientific capabilities of the Very Large Array and has compromised the safety of operation of that facility. In light of the problems with astronomy facilities and in order to avoid similar outcomes for other large facilities, the Subcommittee intends to obtain a better understanding of the current state of repair of the major NSF research facilities for astronomy, physics and geosciences (research ships).

In order to assist the Subcommittee with its inquiries, please provide a status report on each major NSF facility, including the current maintenance budget, the estimated cost of repairs needed to restore the facility to full operational capability, and the estimated cost of any proposed upgrades to the facility which are under consideration. In addition, please provide a status report for the major facilities projects currently underway, including the VLBA, the Greenbank telescope, the 8-meter optical telescopes, the upgrade to the Arecibo telescope, the National High Magnetic Field Laboratory, and the research icebreaker for Antarctica. For each project, the report should include the current schedule for completion and the currently projected total cost relative to the estimated cost at the time of approval for construction.

With kind personal regards and best wishes, I remain

Sincerely,

Rick Boucher, Chairman
Subcommittee on Science

RB/Weg

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

OFFICE OF THE DIRECTOR

January 22, 1992

Honorable Rick Boucher
Chairman, Subcommittee on Science
Committee on Science, Space, and Technology
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

The attached materials are provided in response to your request for an update on the activities of the National Science Foundation in support of major research facilities. As requested, we have provided information both on existing facilities and on new facilities approved for construction.

As you are aware, the Foundation has long recognized the need to support and maintain the major facilities necessary for the conduct of forefront scientific research in the U.S. NSF's ongoing investment in these facilities has provided the research community with access to these unique tools, enabling them to take advantage of exciting new opportunities, and has ensured that the nation continues to meet its scientific needs.

Thank you for your concerns in this area.

Sincerely,

Walter E. Massey
Director

Attachments

Copy Furnished: Honorable Ron Packard

NATIONAL SCIENCE FOUNDATION
FACILITIES CURRENTLY UNDER CONSTRUCTION

The following status reports provide information on major user facilities currently under construction in Astronomical Sciences, Physics, and Materials Research, as well as the new ice-capable research vessel for Antarctica.

GREEN BANK TELESCOPE

After extensive in-house design and planning work in collaboration with personnel from the Jet Propulsion Laboratory, Radiation Systems, Inc. (RSi) of Virginia was selected as general contractor for construction under a fixed-price contract. Ground-breaking for the telescope occurred on May 1, 1991.

Most of the telescope's foundation was in place prior to the onset of the 1991-92 winter season. Manufacture of the steel structure will begin later this year at RSi's facility in Texas, and on-site assembly will begin at Green Bank in 1992. The Green Bank Telescope is scheduled to be completed in 1995. Total cost will be within the appropriated $74.5 million.

VERY LONG BASELINE ARRAY

The Very Long Baseline Array (VLBA) will be completed and become fully operational at the end of calendar year 1992. Currently, eight of the ten antennas have been assembled and erected on their sites. Of these, seven are already operational. The remaining two antennas (Mauna Kea, Saint Croix), will be completed and become operational in the latter part of 1992.

Total cost of the VLBA construction is estimated at $82 million. This cost has remained steady since the project was redefined from a 4-year to an 8-year construction schedule.

GEMINI 8-METER TELESCOPES

The GEMINI 8-Meter Telescope Project plans to construct two 8-meter telescopes, one on Mauna Kea, Hawaii, and the other on Cerro Pachon in Chile, in collaboration with international partners. The estimated total project cost is $176 million, of which the U.S. share will be $88 million. NSF funding for this project was $4 million in FY 1991 and $12 million in FY 1992.

The Science and Engineering Research Council of the United Kingdom voted to join the project in December, 1990, contributing $44 million (25%). Canada has made a commitment to contribute 15% of the project's cost. Discussions are ongoing with other prospective partners for the remaining share.

The GEMINI Project office has been established in Tucson, and current activity is concerned with the design specifications for the telescopes. The project schedule calls for completion of the first telescope on Mauna Kea in 1997 with the Chilean telescope following about two years later. In keeping with Congressional language, efforts will be limited to the Mauna Kea telescope until a final international partnership is established.

ARECIBO UPGRADE

The Upgrade of the Arecibo telescope is being jointly funded by NASA and NSF. The Upgrade has three parts: installation of a Ground Screen, funded by NASA; installation of a Gregorian feed, primarily funded by NSF with some assistance from the NASA/SETI program; and an upgrade of the Planetary Radar, funded by NASA. The current projected cost is $22.9 million, a slight increase over the original projected cost of $22.8 million. Of this amount, $11.8 will be provided by NSF, with the balance from NASA.

Bids have been received for the Ground Screen project, which should be completed by the end of FY 1992. Detailed design studies are underway for the rest of the upgrade. Initial operation of the upgraded telescope is estimated for the end of 1993, with completion of the radar upgrade by mid-1994.

LASER INTERFEROMETER GRAVITATIONAL-WAVE OBSERVATORY

In Fiscal Year 1992, construction activities will be initiated for the Laser Interferometer Gravitational-Wave Observatory (LIGO). Activities for the first year will include: site selection; augmenting the in-house scientific, engineering and management capabilities; and contracting out to industry the vacuum system and beam tube design. The current construction schedule anticipates both sites becoming operational in Fiscal Year 1998. The total project cost is estimated at $213 million, as was stated in the FY 1992 Current Plan.

NATIONAL HIGH MAGNETIC FIELD LABORATORY

The National High Magnetic Field Laboratory (NHMFL) project was approved by the National Science Board in August, 1990. Progress to date is on schedule. Service to high field magnet users will begin in about a year, and the project will be completed in about four years.

The total estimated cost for the NHMFL currently is $148 million over five years. Of this amount, $60 million has been committed by the NSF and the remainder is expected to be provided by the State of Florida. This compares with an original estimated cost of about $120 million. The difference, which will be borne by the State of Florida, is due to revised building construction plans.

R/V NATHANIEL B. PALMER

The R/V Nathaniel B. Palmer, the Foundation's new ice-capable Antarctic research vessel, is being constructed by Edison Chouest Offshore, a private vessel construction and operating firm located in Louisiana. The vessel is scheduled for delivery to the Foundation's civilian contractor, Antarctic Support Associates, at Punta Areanas, Chile, in March, 1992, following which it will commence year-round operations in Antarctic waters.

The Foundation will have a 10-year lease of the vessel. Total funding for FY 1992 is estimated at $7.5 million, with annual costs of between $10 million and $15 million in future years as operations increase and additional scientific instrumentation is purchased. Costs have increased by roughly 30-40% since the vessel was initially approved, largely due to Congressional requirements that the vessel be U.S.-built and U.S.-flagged.

CURRENT NSF MAJOR FACILITIES
IN ASTRONOMICAL SCIENCES, PHYSICS, MATERIALS RESEARCH, & GEOSCIENCES
(Millions of Dollars)

	FY 1992 Estimated Total Budget	FY 1992 Estimated Maintenance	Estimated Repair Needs	Cost of Possible Upgrades
PHYSICS				
Cornell Univ. [CESR]	16.8	2.2	0.5	--
Indiana Univ. Cyclotron Facil	9.8	1.5	0.8	1.5 \1
MSU Natl Superconducting Cyclotron Laboratory	9.5	1.5	0.5	2.25 \1
MATERIALS RESEARCH				
Francis Bitter National Magnet Lab \2	6.3	0.6	--	--
ASTRONOMICAL SCIENCES				
NAIC (Arecibo)	10.5	0.2-0.4	0.9	1.0 \3
NOAO (including KPNO, CTIO, NSO	28.5	0.5-1.0	5.0	15.0 \4
NRAO (including VLA, VLBA)	35.3	2.0-3.0	8.5	36.0 \5
GEOSCIENCES				
Oceanographic Research Ships	31.5 \6	4.7	--	6.0 \7
R/V Polar Duke	4.4	0.3 \8	--	--

NOTES:

1. Physics upgrade funds are for additional large-scale instrumentation (spectrometers).
2. FBNML will not be supported as a user facility after FY 1995.
3. Upgrade funds are for repair and replacement of obsolete equipment at Arecibo.
4. Includes installation of adaptive optics and modern detectors for large telescopes and major upgrade for the McMath Solar Telescope.
5. Major upgrade for Very Large Array (VLA).
6. Through separate programs, NSF expects to provide about $4 million to replace and upgrade scientific and shipboard equipment for UNOLS vessels and $4.2 million for technicians and for maintenance of scientific equipment.
7. Planned mid-life refit of three ships over three years.
8. Maintenance costs are included in the cost of the lease and are not a special charge.

1-13-92

TESTIMONY

SUBMITTED TO

THE SUBCOMMITTEE ON SCIENCE
OF THE
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES

BY

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CHANCELLOR JOE B. WYATT
VANDERBILT UNIVERSITY

ON BEHALF OF

THE HIGHER EDUCATION COLLOQUIUM ON SCIENCE FACILITIES

FEBRUARY 1992

Mr. Chairman and Members of the Subcommittee:

We are pleased to submit this testimony on behalf of the Higher Education Colloquium on Science Facilities, which is chaired by Senator Terry Sanford. Four other members of Congress serve as Vice Chairs of the Colloquium, including Senator John Danforth and Representatives George Brown, Jr., Sherwood Boehlert, and Tim Valentine.

The Colloquium was established in March 1990 to seek consensus on policies and actions needed to ensure that the nation has an adequate and appropriate supply of academic science and engineering facilities for the future.

We would like to comment on the importance and relative priorities of the National Science Foundation's activities pertaining to research infrastructure. For a number of reasons, we find it puzzling that for the second year that an 18 percent expansion of NSF's research funding is proposed, its budget submission provides no funding for the NSF facilities program. At the same time, the fiscal year 1993 budget request allocates approximately 20 percent of the NSF funding growth for capital improvements to national research facilities, such as the new 8 meter telescopes and the National High Magnetic Field Lab. This is not a balanced allocation of resources.

The Colloquium expresses its strong support for restoration of and adequate funding for the NSF Academic Research Facilities Modernization Program. Before giving you details and reasons for our position, we want to briefly state the need the NSF facilities is intended to address.

THE CRITICAL NEED FOR ACADEMIC FACILITIES

We need not remind this committee that the well-being of our nation depends on a skilled and educated workforce. Global competitiveness is driving technological change that is continuously increasing the requirements for advanced training. Unfortunately, the U.S. competitive position is vulnerable. There are serious signs of erosion, for instance, in our ability to provide an adequate supply of our own future scientists and engineers. Some indicators of this erosion are:

- Nearly 50 percent of those entering our graduate programs in mathematics and engineering are foreign students.

- The United States now trails France, West Germany, Japan, and the United Kingdom in the percentage of students selecting engineering as their first degree.

- We are behind all but Japan in the percentage of students selecting the natural sciences.

- Shortages of new faculty in many fields of science and engineering are already upon us.

These signs warn us that we should no longer take for granted that our colleges and universities will be able to supply the scientific and technical personnel needed for global competition.

A major factor that affects our ability to meet the needs for advanced training is the state of academic facilities. While it is hard to quantify, we know that the ability to attract and retain good faculty and students in the sciences and engineering is dependent on the ability to offer them state-of-the-art research facilities.

The problem of obsolescence, inadequacy, and disrepair in the academic research infrastructure has been well documented over the past decade in reports by several prestigious, broad-based groups such as the White House Science Council, the Government-University-Industry Research Roundtable of the National Academy of Sciences, and the Council on Competitiveness, as well as the National Science Foundation and various associations of universities.

According to the latest survey reported by NSF, the amount of deferred repair, maintenance, and new construction for research facilities in America's universities and colleges has increased 40 percent from 1988 to 1990 to a level of about $12 billion.

The conditions we have been describing have been apparent for some time. Yet rather than doing more, the federal government has done less and has backed away from its long-established linchpin role in supporting our academic research infrastructure. In the mid-1960s, the federal government was contributing about 32 percent to the financing of academic research facilities. Currently that share has fallen to about 10 percent, and most of this is for highly specialized installations for energy, space, and defense research.

Sometimes, in our analysis of aggregate data, we lose sight of what is at stake. The consequences of continuing to neglect this backlog of needed facilities are significant and will, inevitably, cost our nation further loss of leadership in a growing number of fields in science and technology.

We do not have to go further than the laboratories of institutions in the states represented on this subcommittee to document this problem. We have appended here statements from a 1989 survey of campuses across the nation of the negative effects that inadequate facilities are having on their research. Included are self-described infrastructure deficiencies from scientists and engineers from universities in Virginia, California, Illinois, Pennsylvania, New York, North Carolina, Iowa, Maryland, and Florida.

The University of Virginia, for example, reports:

> Externally funded research at the University of Virginia is growing currently at an annual rate of 15%. Such growth cannot be continued because we have already saturated our research space. In the College of Arts and Sciences, a group of approximately 6 research faculty in nuclear and high energy physics who generate more than $3M/year in external research support have nowhere to put the equipment which has been purchased with federal funds.....In the School of Engineering and Applied Science, a major grant from the Department of Transportation supporting experimental crash impact research is being severely impeded by the unavailability of suitable research space. In addition, the space available for the support of academic computing is ridiculously inadequate.

At the University of California, Los Angeles:

> Studies in basic and applied molecular biology in relationship to developments in biotechnology are being impaired by the lack of

modern facilities. Such facilities require special fermentation facilities, special environmentally controlled areas and the modern laboratory systems that meet the regulatory requirements that have been recently promulgated in this area.

At the University of Illinois:

In Mechanical Engineering the space is very open and not usable for modern instrumentation. It has been necessary to divide up floor space with wire cages and put laser equipment inside the caged areas. The lasers are used in the diagnostics of combustion and fluid flows. There is no computer control of the engines. The control devises were built in the 20's and 30's. In wind-tunnel-like experiments, there is a need to go to three dimensional studies and to scale up devices by 400-800%. This would require large-capacity vacuum and high-pressure air sources, which are not available....Across the engineering departments in general, only 29% of the research space is considered suitable for use in the most highly developed and scientifically sophisticated research in the field. In the physical sciences this number is higher (49%), but in the environmental sciences the corresponding percentage is only 8%.

At Cornell University:

Another example on the Cornell campus is the Center for Environmental Research. The staff of this center are currently dispersed among four different buildings on the campus. Substantial recent effort in this center has focused on questions related to global environmental change. There appear to be major opportunities for more interdisciplinary basic research to be conducted in this area, and funding for programs in the center has grown substantially over the past two or three years. This center needs about 15,000 square feet to consolidate its central operations in one place and provide a focus for expanding efforts on the global environment...No solution is on the horizon for meeting those space needs, even though a substantial fraction of the work of this center is in the statutory colleges of the university that are supported by the State of New York. Budget difficulties in the state, coupled with pressures for better teaching space in the biological sciences, make it unlikely that the state will be able to respond to such space needs for a period on the order of five years. Even though basic interdisciplinary research on global environmental effects is of vital importance to society, it is unlikely that programs of the required magnitude can be mounted within the space constraints of the institution. Graduate students will not be trained in sufficient numbers to meet national needs in the environmental area as a result of current shortfalls in research space.

These are just four examples of excellent institutions that have outstanding faculty-researchers, the most sophisticated equipment, but whose facilities, sadly, are not up to par. Unfortunately, many universities and colleges have similar problems. Research experiments and programs are being suspended, postponed, delayed, and canceled because of inadequate or obsolescent facilities in institutions, both large and small, across the nation.

We recognize that the federal government alone cannot be expected to solve the research facilities problem. For that reason we are developing a national strategy for continuing support of research facilities that will embrace all parties concerned, including the universities, the states, the private sector, and the federal government.

Our research institutions already contribute substantial resources of their own. For instance, more than half of the funds for repair and renovation of academic science and engineering research facilities in 1988-89 came from institutions' own resources, according to an NSF survey. Most of the remaining funding for renovation came from state funds in the case of public institutions and tax-exempt bonds and philanthropic donations in the case of private institutions. With respect to funds for new facilities construction, private institutions obtained 70 percent of the construction funding from donations and debt financing, while public institutions acquired almost half of their construction funding from state and local governments.

In addition to devoting substantial portions of their own resources to the problem, research institutions are seeking creative solutions to the problem. The Colloquium, for instance, has set up a task group to find more efficient and less costly methods for planning and building research facilities while making them conform to new environmental, health, and safety regulations.

Despite the promise of these efforts for the future, it is our belief that a comprehensive program for academic research facilities must have the participation and leadership of the federal government to succeed.

THE UNIQUE ROLE OF THE NSF ACADEMIC FACILITIES PROGRAM

In this context, the NSF Academic Research Facilities Modernization Program becomes crucial in addressing the academic facilities problem . This NSF program is unique in that it is the only federal program that provides funds for renovation of general-purpose academic science and engineering facilities and in that institutions compete for awards in three groups based on their previous level of NSF funding. This ensures that similar institutions compete only among themselves for a targeted percentage of program funds.

In the first round of awards, not only major research institutions received grants, but also a significant amount went to institutions that receive relatively little federal R&D funding. Of the 78 awardees, 55 are below the top 100 in receipt of federal funds, and 11 are HIstorically Black Colleges and Universities and other institutions with substantial minority enrollments. Among the colleges and universities that received NSF facilities grants are 41 institutions in 14 states represented on this subcommittee. (See Appendix B for a list of awards.)

In our view, this program has been the federal government's only promising response to the general academic research facilities problem in 20 years. Last year it was funded at only $16.5 million, a fraction of its current $250 million annual authorization.

We recommend restoring and increasing funding for this program to its authorized level. While recommending full funding, which is no more than half of the amount urgently requested by the White House Science Council in 1986, we recognize that reality this year might require reducing this in some amount. The reality of the future of science, however, almost cries for several times the $56.5 million appropriated since the program's inception in 1988. Facilities funding, in our view, should be regarded as a necessary investment in the future health of the U.S. research capability. There are a number of other reasons for making this modest investment. Let us address four of the major ones:

1. The need is well documented, and the amounts requested are very modest compared to the need. Moreover, the critical role of facilities in enabling our scientists

and engineers to continue to do first-class research and train future scientists and engineers has never been more urgent.

2. The Academic Research Facilities Modernization Program has had an excellent response despite its short life. In the first round of competition, more than 425 proposals were received requesting $320 million. The $39 million awarded to 78 universities, colleges, and nonprofit institutions in 37 states was augmented by $61 million in matching funds. This means that for every $2 awarded, the government leveraged $3 in nonfederal resources. Experience with similar leveraged programs shows that the leveraging continues after awards are made.

3. The practice of earmarking, or voting funds for individual research facilities without merit review, is increasing. In the absence of adequate funding for the NSF program and establishment of other broad, competitively reviewed programs of infrastructure awards, earmarks are estimated to be in excess of $500 million for FY 1991, or 30 times the amount appropriated for the NSF facilities program last year. As the only existing federal alternative to earmarking, increased funding for the NSF facilities program is essential.

4. The ability to do leading edge research is becoming increasingly dependent on the ability of universities to acquire instrumentation and build adequate facilities. Planning for research projects in many advanced fields of science and engineering increasingly involves planning for new instrumentation and facilities. Since NSF provides a significant proportion of federal funds for basic research in academia, investigators who win research awards on merit should not have to be turned down because their institutions cannot find funds for the necessary modernization of facilities. This is not a matter of conjecture. We turn to our own institutions for examples. The lack of facilities has been responsible, in part, for terminating a proposal to buy a large Van de Graff accelerator at Vanderbilt University and responsible for the delay in creating an institute for molecular medicine. It makes no sense for the National Science Foundation to have funds for research, funds for instrumentation, funds for national facilities, but no funds for general-purpose academic facilities.

Turning to the proposal to fund state-of-the-art instrumentation, we can genuinely applaud the wisdom of a program to satisfy this critical need. We are puzzled, however, by what appears to be an attempt to draw a sharp distinction between the need for research facilities and the need for research instrumentation. The two are mutually dependent and virtually inseparable. Laboratory benches with "clean" electrical power, a pure water supply, and a host of other services including bottled gases and the like are a prerequisite for the instrumentation of much science and engineering research, particularly for small projects. Fume hoods are mandatory for many experiments in both small and large projects. Supercomputers require a host of special facilities including sophisticated networks to make them accessible by their research users. For large projects, the special facilities required for state-of-the-art instrumentation are paramount.

In sum, virtually no research instrumentation can be installed and utilized without requiring facilities adequate for the purpose. And in most cases, the facility requirements of today's research instrumentation are very sophisticated and often quite expensive. From our perspective on the relationship between research, instrumentation, and facilities, it makes sense, if funding for expensive, sensitive equipment is to be expanded, to ensure that there will be adequate housing for it.

Therefore, it would seem prudent to make academic research facilities modernization a continuing program at NSF. There is precedent for this. In the early 1980s, NSF responded to reports of a documented deficit in instrumentation by steadily increasing the share of its expanding research base that it allocated to instrumentation. The share of NSF research awards allocated to instrumentation has increased from about 6 percent in 1979 to about 12 percent in 1990. This is entirely necessary and appropriate. Investment in facilities ought to have similar treatment.

For the reasons we have outlined briefly, we strongly urge your committee to advocate establishment and strengthening of merit-based, leveraged federal facility programs not only at NSF but at other federal agencies with research programs. We feel that these recommendations are consistent with the Congress' past commitments to academic research and education and to maintaining U.S. competitiveness. Mr. Chairman, the basic research upon which our future national vitality depends, requires investments in people, equipment, <u>and</u> facilities.

APPENDIXES

Appendix A Excerpts from "Statements by Public and Private Universities on Research Facilities Needs in Six Fields," Ad Hoc Committee on Academic Research Facilities. University Research Facilities: A National Problem Requiring a National Response. Washington, D.C.: AAU and NASULGC, June 1989.

Appendix B National Science Foundation News Release, "NSF Announces Awards Totaling $39 Million for Academic Research Facilities," January 24, 1991.

APPENDIX A

EXCERPTS FROM STATEMENTS BY PUBLIC AND PRIVATE UNIVERSITIES ON RESEARCH FACILITIES NEEDS IN SIX FIELDS *[1]

Biological Sciences

THE JOHNS HOPKINS UNIVERSITY

AIDS: A large program of AIDS and AIDS-related research at Johns Hopkins is limited and impeded by obsolete facilities, and modernization and renovation funding is largely unavailable. Research involving the live HIV virus requires P3 (Physical Containment Level 3) laboratory facilities: isolation laboratories with negative air pressure control and maintenance capability; airlocks; emergency isolation capability; separate and isolated ventilation systems; lockers and showers for staff; special aerosol containment hoods; non-public thoroughfares and hallways; etc. The present Hopkins research faculty would probably expand AIDS research activities to nearly double its present level (approximately $30 million annual expenditures) if it were possible to upgrade present facilities. Faculty simply do not respond to requests for research proposals in areas of high interest to them because of facilities limitations. The effect of this is that much potentially important AIDS research is deferred, not done at all, or not done as rapidly or as well as it might be done.

NEW YORK UNIVERSITY

In our Biology Department, a number of research efforts are hampered by inadequate facilities. In some areas of biological research, investigations are hampered by the lack of up-to-date central facilities, including a DNA sequencer and synthesis facility, and a spectro-fluorimeter. In plant molecular biology and plant systematic biology, greenhouses are an essential facility; in the absence of a modern greenhouse, our biology investigators are unable to pursue research in this area.

UNIVERSITY OF CALIFORNIA

Less than 50% of the available research space is "suitable for use in the most highly developed and scientifically sophisticated research in its field," according to input provided by S/E units. Research is most upgraded with institutional funds in connection with recruitment and retention of faculty. Little upgrading can be accomplished through research grant funding. We need augmented funding levels to expand our program of renovations to include the utility and service infrastructure within buildings. One of our middle-size bioscience units (not included in the three-phase bioscience space upgrading) has described the departmental situation as follows:

Controlled Temperature and Clean Air Laboratories (Highest Priority)

Controlled temperature in our laboratories is now even more important than in the past. Modern research instruments such as our recently acquired Fourier-transform infrared (FTIR) and inductively coupled plasma (ICP) spectrographs require environments with very limited temperature range to perform optimally. Although air conditioning is rarely needed for comfort in Berkeley, these instruments with their highly precise optical systems and associated computers do require it. Studies of soil water transport, water extraction, measurement of soil water potential, soil rheology and soil microbiology all require con-

1. Source: The Ad Hoc Committee on Academic Research Facilities. *University Research Facilities: A National Problem Requiring a National Response.* Washington, D.C. AAU & NASULGC, June 1989.

trolled temperature environments. The department presently has only one very small constant temperature room to accommodate these activities, and this facility has a history of being inoperative for very long periods (over 1 year in 1 episode), apparently because of the difficulty in obtaining parts for an obsolete system.

The air blown into labs and offices by the Hilgard ventilation system is extremely dirty. Improvised filters put over outlets are inefficient expedients. They are overloaded with particles in a short time. The fiberglass filter over the air outlet above the computer where I am now sitting has reached "breakthrough" in less than four weeks.

Fume Hoods with Acid Traps (Very high priority)

Digestion of soil and plant materials requires strong reagents and high temperature. At present there is only one hood in the department with a perchloric acid trap and which is equipped with scrubbers to remove nitric acid fumes. The provisions for trapping the potentially explosive perchloric acid and corrosive niotric acid fumes were improvised with department resources. While this one arrangement is effective, it is clearly inadequate for the department's needs. All department laboratories doing wet chemistry should have hoods with acid filters/traps for safety, environmental protection and preservation of the ducts.

UNIVERSITY OF CALIFORNIA - LOS ANGELES

Studies in basic and applied molecular biology in relationship to developments in biotechnology are being impaired by the lack of modern facilities. Such facilities require special fermentation facilities, special environmentally controlled areas and the modern laboratory systems that meet the regulatory requirements that have been recently promulgated in this area.

THE UNIVERSITY OF IOWA

Outdated facilities are impacting adversely on the University of Iowa's undergraduate and graduate education programs. For example, in biology, as intensive laboratory training in molecular techniques is required for large numbers of undergraduate students, classroom laboratory space once used only for desktop experiments must be remodeled and rewired to handle multiple centrifuges, power packs, refrigerators, personal computers, tissue culture and chemical hoods. The problem is repeated in each of the University's science and engineering departments for which a myriad of automated and electronic equipment is essential for basic undergraduate laboratory instruction.

The eventual proof of the biologic process is the living animal. As our knowledge increase, so the effects of the various agents and insults are becoming clearer and the demand for clean, pathogen-free animal space is increasing. Added to this is the provision for transgenic animals, in which the ultimate test of the new DNA-technology is conducted. Researchers in our biomedical area, particularly in out internationally renowned cardiovascular research center, must presently delay or forgo studies utilizing dogs and primates because of the current limited capacity of existing facilities. Proposed U.S. Department of Agriculture regulations will require a doubling of space for housing and exercise of dogs and primates. In addition, there is a critical need to develop special facilities for the use of transgenic mice, containment of pregnant sheep, and improved and expanded aseptic surgical research facilities. These are all examples of the important needs to improve the infrastructure for health related studies. It is estimated that the University of Iowa's will need to invest $6.4 million in improvement and expansion of animal facilities to comply with regulations and to meet the expanding biomedical research needs. This investment is in addition to $6 million that has been spent by the University since 1979 to bring the University into compliance with the USDA regulations and PHS guidelines.

UNIVERSITY OF MARYLAND

On our campus, some of the buildings have air conditioning powered by steam; this arrangements results in shut-downs for the cleaning of the equipment and in outages, when power is interrupted. This antiquated set-up adversely affects research endeavors in biochemistry and in the animal sciences.

Our microbiology program was housed for years in an antiquated building with make-shift arrangements for new research requirements. Clearly, the inadequacy of the facilities prevented the department from beginning serious work in certain new biotechnology areas.

UNIVERSITY OF PITTSBURGH

Obsolete X-ray crystallography facilities and equipment in our Departments of Biological Sciences and Crystallography, and in our medical school's basic science departments constrain and impede various research projects on protein structure being conducted at our University.

Our Department of Biological Sciences and Behavioral Neuroscience are in need of a central animal housing facility and state-of-the-art tissue laboratories in order better to capitalize on the talents of their faculties and graduate students.

UNIVERSITY OF SOUTHERN CALIFORNIA

All of the Department of Biological Sciences portions of Geological Sciences and Chemistry are housed in buildings listed above and the research and educational programs offered by these departments is being adversely affected by inadequate and/or obsolete facilities. A few examples:

A Marine Biology we are trying to expand an exciting research effort which combines biochemical, microbiological and molecular techniques in the study of the early development stages of invertebrate organisms. In addition to basic science, the work has significant application in biotechnology and agriculture. However, the research is being severely hampered by obsolete facilities. All of the laboratory bench-tops are coated wood and unusable or incompatible with the use of chemicals, stains, radioisotope tracers routinely used by the faculty and graduate students. (Chemical hoods in the building no longer meet code requirements for many acids are highly volatile or toxic substances.) The laboratories are not air-conditioned and become unbearably warm in summer months, to the inconvience of researchers and the detriment of computers and electronics. Expansion of the program can only be done as labs in the building are renovated at considerable time and expense. The Molecular Biology program is housed in buildings now more than 25 years old and in need of extensive renovation of the hood ducting, air supply system, benching and countertops (which contain an asbestos impregnated epoxy) and laboratory layout. The lack of adequate laboratory facilities is adversely affecting the development of this very important component of the Biological Sciences. Without well-equipped, modern facilities, the Section is at a disadvantage in the recruitment of both junior and senior level faculty. The program has critical deficiencies in the areas of molecular, cellular and developmental biology, and we are trying to fill this need by building research efforts in gene control during development, cellular growth controls and commu nication between cells and signal transduction. However, these efforts are limited by poor quality of existing research space and, again, extensive renovation must occur before we can proceed.

Chemistry

CARNEGIE MELLON UNIVERSITY

The major place in which we had as adverse effect is in the teaching of chemistry. We have a brilliant new idea for education that will increase the number of majors in both high school and college for chemistry. Unfortunately, in order to implement our ideas, we need a modern facility. We also have some original ideas on ways in which new laboratories should be constructed. We are trying to raise $7 million to proceed with this project. In the meantime, the idea is languishing, and we are not doing as good a job as we could for the education of chemists.

The chemical industry is worrying about the future supply of chemists, because this are is no longer drawing the numbers of students at either the undergraduate or graduate level that are needed by the industry. Obviously, this industry remains an important one for the United States.

IOWA STATE UNIVERSITY

At Iowa State University we do have programs that are severely affected by obsolete research facilities. In chemistry, traditionally one of the strongest programs at Iowa State University, we are in the midst of a major renovation project of our core chemistry facility. Our present facility of more than 200,000 square feet houses more than 30 chemistry research groups. Unfortunately, our chemistry research groups are concentrated in areas of traditional strength at Iowa State (materials, sciences, organic chemistry, etc.) and because they occupy all present space we are limited in our ability to grow chemistry research activities into new areas where interdisciplinary research is required. For instance, we have a strong interest in developing a natural systems chemistry program that will support and enhance our movement into fundamental agricultural research. To do this we need facilities and equipment on a relatively major scale. We are unable to provide such facilities or equipment, in spite of massive state investment, and as a result we feel that certain new knowledge may not come about. It's important to remember that it's not as if we can eliminate our existing chemistry program, which is successful both in terms of research and in its terms of teaching, to move into new areas because we cannot. We have developed ongoing streams of knowledge and student production that justify their continuation. But now to move into broader and more interdisciplinary programs linking chemistry with other activities on campus we find that we are severely facilities and equipment limited. In our opinion this does result in an impedance of the research enterprise.

THE JOHNS HOPKINS UNIVERSITY

Molecular and atomic chemistry research at Hopkins is hampered by lack of adequate facilities to house modern equipment, such as state-of-the-art NMR and X-ray diffraction instruments. This situation is compounded by the difficulties in computer/information networks and similar systems. This adversely affects research involving, for example, DNA chemistry, polymers, and advanced materials, each of which is a critical area of technology for the nation.
University of Pittsburgh

Very recently, one of our senior organic chemists who pioneered the field of molecular recognition, a field of widespread interest and application, left the University for another institution because we were unable to provide him with adequate research facilities and state-of-the-art equipment needed to establish an Institute for Molecular Recognition.

UNIVERSITY OF SOUTHERN CALIFORNIA

There are a number of exciting new research opportunities in organic and organic metallic chemistry which the faculty of Chemistry would like to exploit but find themselves handicapped by the aging and inadequate laboratory facilities available. Although a few of the laboratories have recently been improved, the majority of the hoods, ducting and air supply system is substandard and in some cases no longer meets code requirements. The problems related to laboratory facilities are not only restricting the expansion of existing research programs, they are increasingly becoming a major hindrance in the recruitment of replacement and new faculty. At the present time we are losing one junior professor because of problems related to research space.

Engineering

CORNELL UNIVERSITY

An example of a major program at Cornell University which is adversely affected by obsolete research laboratories is the School of Electrical Engineering. This school occupies a building which was built in the mid-1950's in order to house a planned, much larger program in undergraduate education. The planning did not include any element of research facilities. Over the past 30 years the School of Engineering has evolved into one of the leading research departments in its field in the United States. The research function, including office space for graduate students, postdoctorals, research associates, shops and research laboratories was shoe-horned into the existing building, or, in some cases, laboratories were placed in off-campus locations or in other buildings. As research and instructional pressures mounted due to the increased student interest in electrical engineering, space devoted to instruction shrank. One consequence was the reduction of the required junior-year laboratory course from five hours per week in the laboratory to three hours per week. This allowed twice as many laboratory sections to be taught. Instructional material was taken out of the course in order to complete it in three hours instead of the five previous. Subsequently, the two-semester sequence was reduced to a single semester and additional teaching laboratories which were used for specialized senior-level courses were merged or eliminated. The research laboratories, being placed in former classrooms, instructional laboratories, offices, and so forth are totally inadequate. They generally have no humidity control, no air conditioning, and so forth, which makes use of electronic equipment difficult on hot days. Research space per faculty member in the school is less than 500 square feet, and compared to about 2000 square feet in comparable departments. As a consequence, the magnitude and quality of research and quality of undergrad uate instruction which is done in this school, an area vital to national competitiveness, is severely limited by inadequate space.

As a consequence of this situation and similar pressures in other departments in the engineering college, the college prepared a master plan for meeting space needs. The first element of this master plan was to have been construction of a laboratory building for the School of Electrical Engineering. Because of immediate time pressures to house the new supercomputing facility, the college's space needs were placed second in priority. Even though the college master plan was created three years ago, it now appears that it will be at least five to ten years before resources can be found to begin construction on a laboratory building for electrical engineering. In this school, the space pressures on both teaching and research will therefore have spanned the entire professional careers of a generation of faculty members.

A third area of need is closely related to the microelectronics area of the School of Electrical Engineering. The university is currently trying to organize joint university/corporation efforts for research on optoelectronics, electronic packaging, production of semiconductor devices, and advanced lithography. Those strategic liaisons with corporations envision environment which will contain both open research by university people and collaborative research conducted by employees of several different corporations. Corporations might also be able to rent space in an adjacent facility to do their own proprietary work. In this particular case, it may be feasible to pay for the needed space by the program revenues, although it will be a substantial challenge to provide this space on required time schedule about 18 months). If we are unable to provide this space, the chance for major industrial collaborations which could affect the national competitive picture in these important areas will be severely compromised.

UNIVERSITY OF BUFFALO

In all areas of engineering, including materials, manufacturing engineering, biomedical and biochemical engineering, and engineering instruction, new technology is developing so rapidly that it is impossible for the Engineering School to have available the latest hardware and, in the cases where computing is part of the program, the latest software.

As a specific example, the materials research programs offered through our Departments of Chemical. Electrical, and Mechanical Engineering face the following:

Our high resolution microscopy and analytical facilities, which must support the materials efforts, are wholly inadequate. We have faculty with the talent but our research laboratories are either without the appropriate equipment (clean rooms, furnaces, CVD facilities, MBE, microscopes, etc.) or have an inadequate, technologically obsolete capability.

UNIVERSITY OF FLORIDA

An accurate estimate of the need for space to feed the department's rapid growth in research is thirty thousand square feet. There are many good reasons for this additional need for space, but the most compelling is that the department has hired ten new faculty in the last eighteen months, among them the college's first Eminent Scholar, Dr. Tang Sah. Dr. Sah occupies the Robert C. Pittman endowed chair. He is a leading researcher in semiconductor electronics. In the 1950's he worked with William Shockley, Nobel Laureate and co-inventor of the transistor, as a senior member of the technical staff of the Shockley Transistor Corp., leading a group that developed the first digital watches. He continues to make major contributions as is evident by his receiving the Jack Morton Award from IEEE this year. We have attracted Dr. Sah to the University, but are now unable to meet his space needs. his group alone will secure over $1,250,000 in research funding next year. The work is largely experimental and requires significant amounts of high-quality (like clean rooms) space. To quote Dr. Sah's closest colleague, Dr. Fred Lindholm:

"1. We cannot get the experimental stations set up in which to do our research.
2. We cannot add the graduate students coming this fall who need to use these work stations.
3. We cannot add postdocs we need to help us do this research and to assist in educating our graduate students.
4. We cannot have the use of Professor Sah's reprint files or his journals.

Accordingly, our research and education via research is severely compromised, and our ability to bring in substantive research funding to provide for graduate student education and the maturation of our junior faculty associates is severely limited."

This is not a new problem. After being with us for less than eighteen months, Dr. Luis Figueroa, a well-known expert in laser technology, resigned in June of 1987 because of inadequate facilities. In his letter of resignation he states, "When I was hired, I naively assumed I would get space to build a semiconductor laser characterization lab to support my research. I was mistaken! If i would have known about the magnitude of the space crisis before i was hired, i would have either negotiated using different methods or found a better arrangement elsewhere.

UNIVERSITY OF ILLINOIS

In Mechanical Engineering the space is very open and not usable for modern instrumentation. It has been to divide up floor space with wire cages and put laser equipment in side the caged areas. The lasers are used in the diagnostics of combustion and fluid flows. There is no computer control of the engines. The control devised were built in the 20's and 30's.

In wind-tunnel-like experiments, there is a need to go to three dimensional studies and to scale up devices by 400-800%. This would require large-capacity vacuum and high-pressure air sources, which are not available.

A proposed center for the study of refrigeration that involves industry-university cooperation lacks the space and environmental controls to conduct the studies properly. A major activity involves the replacement of CFC's, and the substitute materials are so exotic that leak detection is difficult and there are no known sealing materials. Tribology studies with these materials are needed but there are no facilities in which to conduct these studies.

Across the engineering departments in general, only 29% of the research space is considered suitable for use in the most highly developed and scientifically sophisticated research in the field. In the physical sciences this number is higher (49%), but in the environmental sciences the corresponding percentage is only 8%.

UNIVERSITY OF PITTSBURGH

X-ray diffraction facilities and equipment in the Department of Materials Science and Engineering are 15-20 years old, and thus state-of-the-art research on polymers just cannot be done using them; our faculty who need state-of-the-art X-ray diffraction facilities and equipment must go elsewhere to do their X-ray diffraction work.

Moreover, due to inadequate space and lack of equipment, our School of Engineering is unable to establish a cell biology laboratory that is needed for the School's developing research and graduate training program in bioengineering.

The building that houses our School of Engineering was designed in the late 1960's and completed in 1972. At that time, the building air conditioning was adequate relative to needs, but its air conditioning is today inadequate relative to current needs. As a consequence, each time a new laboratory is set up, a separate air conditioning system must be added at a cost of approximately $20,000. The cost to upgrade the building's central system is approximately $350,000 to $400,000. Obviously, given finite University and School of Engineering resources, funds used for air conditioning additions or upgrades cannot then be otherwise used in support of the School's research, training, and service activities.

UNIVERSITY OF SOUTHERN CALIFORNIA

Photonics/Optical Computing research is greatly hampered by the lack of adequate laboratory space. The materials processing side in particular requires very extensive (and expensive) facilities. This is an extremely important new technology that could lead to the so-called "sixth-generation" computers.

We have millions of dollars of government research support including a U.R.I. in this area, and have one of the top two or three research groups in the country. The potential impact of their research and the necessary technology transfer will be compromised if new facilities are not created.

Manufacturing is another vastly under spaced and under-equipped area. We have major government and industry support through our Institute for Manufacturing and Automation Research (IMAR), but no real facility in which to conduct meaningful research.

The Division of Natural Science and Mathematics occupies five buildings in which the laboratory research facilities are obsolete or substandard, and a sixth in which the facilities are marginal. Only two buildings in the Sciences have adequate research facilities. The worst case are buildings more than 50 years old, in which there are acute problems with electrical services, hoods and venting systems, plumbing, benching, heating and air conditioning systems and general design of the laboratories. To varying degrees, all of the subpart buildings share these problems.

UNIVERSITY OF VIRGINIA

Externally funded research at the University of Virginia is growing currently at an annual rate of 15%. Such growth cannot continue because we have already saturated our research space.

In the School of Engineering and Applied Science, a major grant from the Department of Transportation supporting experimental crash impact research is being severely impeded by the unavailability of suitable research space. In addition, the space available for the support of academic computing is ridiculously inadequate.

Environmental Sciences

CORNELL UNIVERSITY

Another example on the Cornell campus is the Center for Environmental Research. The staff of this center are currently dispersed among four different buildings on the campus. Substantial recent effort in this center has focused on questions related to global environmental change. There appear to be major opportunities for more interdisciplinary basic research to be conducted in this area, and funding for programs in the center has grown substantially over the past two or three years. This center needs about 15,000 square feet to consolidate its central operations in one place and provide a focus for expanding efforts on the global environment. The space needs include both offices and laboratories. No solution is on the horizon for meeting those space needs, even though a substantial fraction of the work of this center is in the statutory colleges of the university that are supported by the State of New York. Budget difficulties in the state, coupled with pressures for better teaching space in the biological sciences, make it unlikely that the state will be able to respond to such space needs for a period on the order of five years. Even though basic interdisciplinary research on global environmental effects is of vital importance to society, it is unlikely that programs of the required magnitude can be mounted within the space constraints of the institution. Graduate students will not be trained in sufficient numbers to meet national needs in the environmental area as a result of current shortfalls in research space.

Materials Sciences

CARNEGIE MELLON UNIVERSITY

In the research area, there is a major shortage of space for the accomplishment of large-scale research in the areas such as robotics and advanced materials. We have been renovating a number of buildings, but we are still short of the space that we need. We have a series of original ideas on the handling of the nuclear cleanups, and we need more space for constructing the robots that will be able to move into a nuclear plant or other hazardous areas to eliminate the risk to human beings. We are trying to find money and space to do this. In the meantime, the research is being held back. Similarly, research in electronic and other non-metallic materials is limited by space and equipment. We have a major national problem, and progress is being impeded by the lack of facilities. We are in grave danger of being unable to compete in the international arena in electronics and advanced materials.

STANFORD UNIVERSITY

Modern materials research involves building materials atom layer by atom layer. This work cannot be expanded because of the lack of a building to house the special equipment. Such equipment requires special facilities providing adequate vibration isolation and systems to handle the wide range of gases and liquids, some with highly hazardous or with unknown properties used in atomic-level artificially structures materials. The materials affected include high-temperature superconductors, high-speed transistors, new advanced lasers, and new lithographic techniques.

UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

Advanced Electronic Materials Processing program is not advancing as rapidly as it could if adequate space were available. If legislative funding for new space, which has been requested, is not forthcoming, this nationally competitive program may be in jeopardy.

UNIVERSITY OF PITTSBURGH

Inadequate research facilities and insufficient numbers of available scanning tunneling electron microscopes and ion microscopes, and the lack of a tandem accelerator for thin-film analysis are impeding our research and graduate programs in surface science and materials science and engineering.

Physics

UNIVERSITY OF CALIFORNIA - LOS ANGELES

Studies in high-energy and plasma physics are being impaired by the lack of high bay spaces and the infrastructure components (electrical and plumbing) required for medium and large-scale experiments. Facilities for such mesoscale experiments are becoming essential for advances in the physical sciences and engineering.

UNIVERSITY OF FLORIDA

Approximately two years ago the Department of Physics at the University of Florida decided not to recruit anyone with a specialty in experimental physics. All available lab space has been exhausted. Therefore, only theoretical physicists were recruited. Basically, experimental physics has come to a halt unless new space becomes available.

UNIVERSITY OF VIRGINIA

Externally funded research at the University of Virginia is growing currently at an annual rate of 15%. Such growth cannot be continued because we have already saturated our research space. In the College of Arts and Sciences, a group of approximately 6 research faculty in nuclear and high energy physics who generate more than $3M/year in external research support have nowhere to put the equipment which has been purchased with federal funds.

National Science Foundation

NEWS

Jeffrey Norris
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For Release:
January 24, 1991
NSF PR 91-3

NSF ANNOUNCES AWARDS TOTALING $39 MILLION FOR ACADEMIC RESEARCH FACILITIES

The National Science Foundation today announced awards totaling $39 million to 78 colleges, universities, and nonprofit institutions nationwide to repair and renovate laboratories and other research facilities used for scientific and engineering research and research training.

To help modernize research facilities the $39 million from NSF will be combined with over $61 million in institutional, state and local government, and other funds to provide over $100 million in total support for projects in 37 states.

These are the first awards to be made under NSF's Academic Research Facilities Modernization Program, established by the Congress as part of the Academic Research Facilities Modernization Act of 1988. NSF funds for the awards announced today come from both fiscal year 1990 and 1991 appropriations.

The recipients of the awards include 26 baccalaureate- and master's-degree-granting institutions, 43 doctoral-degree-granting institutions, and nine nonprofit research institutions, including 3 museums and one consortium.

The awards are the result of a two-phase competitive process in which 425 institutions submitted proposals. They competed in

-more-

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one of three groups based on the institution's level of previous NSF research and development funding.

This unique program feature, which had similar institutions competing only among themselves for a targeted percentage of program funds, helped ensure not only that major research institutions would receive support, but also that a significant number of awards would go to institutions which receive relatively little federal research and development funding. Proposals were required to include commitments of at least 50 percent matching/cost-sharing from other sources.

The 78 awardees include 23 Group I major research institutions, which received over $17.2 million or approximately 44 percent of the awarded funds; 15 Group II institutions, which received $8.5 million or 22 percent of the awarded funds; and 40 Group III institutions, which received $13.3 million or 34 percent of the awarded funds. Included in the above numbers are 11 Historically Black Colleges and Universities and other institutions with substantial minority enrollments, which received $5.4 million, 14 percent of the awarded funds.

The NSF awards range in size from $74,484 to Winona State University in Minnesota, to $1.9 million for Duke University in North Carolina. The largest total project involves a $1.7 million NSF award toward a $6.6 million renovation of chemistry research facilities at the University of Tennessee at Knoxville. Project durations range from less than 12 months to more than 3.5 years. Facilities being revitalized under the NSF-funded projects range in age from 15 to 118 years; the average facility age is 38 years.

Projects typically involve the renovation of laboratories and facilities; the upgrading or replacement of plumbing, heating, ventilation, air conditioning, and electric power systems; and the replacement of fume hoods, laboratory benches, and other fixed equipment.

In many cases the awards provide an opportunity for first-time-ever renovation of academic research facilities. This is true at Fisk University, for example, where funds will be used to upgrade a 60-year-old chemistry and physics building, and at Emory University, where a 41-year-old psychology building will be renovated.

Among undergraduate schools, the 39-year-old chemistry facilities at Grinnell College in Iowa will undergo renovation, as will the biology facilities at Wisconsin's Beloit College. Still other grants will enable renovation to the University of Kentucky's chemistry and physics building, Morgan State University's Science Complex, MIT's water resources and environmental engineering lab, and California's Point Reyes Bird Observatory.

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ATTACHMENT: List of Academic Research Facilities Modernization Program awards.

NATIONAL SCIENCE FOUNDATION ACADEMIC RESEARCH FACILITIES MODERNIZATION PROGRAM AWARDS

STATE / INSTITUTION	PROJECT DIRECTOR	AWARD	ACADEMIC RESEARCH FACILITIES MODERNIZATION PROJECT
ALABAMA			
Marine Environmental Science Consortium	George F. Crozier	585,000	Renovation and Modernization of Marine Science Hall, Dauphin Island Sea Lab
Tuskegee University	Walter J. Sapp	950,000	Modernization of Research Facilities for Chemistry, Physics, and Computer Science
University of Alabama	Drury S. Caine	1,060,000	Renovation of Chemistry Research Facility
ARIZONA			
University of Arizona	William P. Cosart	400,000	Renovation of the Geology-Mines Building
ARKANSAS			
University of Arkansas - Fayetteville	John G. Hehr	500,000	Renovation of Physics Research Facilities
BERMUDA			
Bermuda Biological Station for Research	Anthony H. Knap	200,000	Modernization of Conklin Marine Science Laboratories
CALIFORNIA			
Cal State University - Los Angeles	Joseph Bragin	750,000	Renovation of Research/Research Training Space in Biological Sciences Building
Harvey Mudd College	Larry Hartwick	1,025,000	Renovation of Jacobs Science Center Chemistry and Physics Facilities
Natural History Museum of LA County	Joel W. Martin	103,992	Replacement of Biochemical Systematics Laboratory
Point Reyes Bird Observatory	Nadav Nur	151,000	Renovation and Repair of Palomarin Field Station
Rancho Santa Ana Botanical Garden	Thomas S. Elias	400,000	Renovation of Botanical Research Facilities
San Diego State University	Donald R. Short	300,000	Renovation of Geological Sciences Research Laboratories
Stanford University	Harden M. McConnell	1,500,000	Renovation of Stauffer Chemistry - Chemical Engineering Complex
University of California - San Diego	Edward A. Frieman	550,000	Renovation of Multi-Disciplinary Research Facilities
University of San Diego	Louis E. Burnett	131,000	Renovation of Laboratories for Microscopy Research and Research Training
University of the Pacific	Michael J. Minch	212,000	Biochemistry Research Laboratory Renovation
COLORADO			
Colorado State University	James H. Gibson	361,414	Facilities Replacement and Renovation - Natural Resource Ecology Laboratory
Rocky Mountain Biological Laboratory	Susan E. Allen	100,000	Modernization of the Barclay Biology Laboratory
CONNECTICUT			
Yale University	Michael E. Zeller	950,000	Modernization of Research Space for Atomic, Molecular, and Optical Physics
FLORIDA			
Florida A&M University	Frederick Humphries	650,000	Renovation of Biology, Chemistry, and Physics Research Facility
GEORGIA			
Emory University	Howard A. Rollins	700,000	Renovation of Psychological Research Building
Morehouse College	Oliver R. Delk	950,000	Renovation of Biological Sciences Building (Hope Hall)
GUAM			
University of Guam	Robert H. Richmond	130,795	Modernization of the Marine Laboratory
IDAHO			
University of Idaho	Peter R. Griffiths	1,300,000	Renovation of Chemistry Department Support Systems
ILLINOIS			
Field Museum of Natural History	John R. Bolt	375,000	Renovation of Paleontological Research Facilities
INDIANA			
Ball State University	Scott E. Pattison	120,000	Exhaust Hood Replacement in the Department of Chemistry
Earlham College	Brent Smith	129,000	Renovation of Biology Research Facilities
IOWA			
Grinnell College	James E. Swartz	250,000	Renovation of Chemistry Research Facilities
Iowa State University	Howard R. Shanks	275,000	Modernization of Microelectronics Research Center Research Facilities
Luther College	Roger M. Knutson	125,000	Modernization of Biology and Chemistry Research Training Space
KANSAS			
University of Kansas	Frances D. Horowitz	299,839	Modernization of Chemistry Research Space
Wichita State University	Melvin H. Snyder	116,000	Renovation and Modernization of Aerodynamic Laboratory
KENTUCKY			
University of Kentucky	Leonard K. Peters	690,000	Chemistry and Physics Research Facility Modernization Project
MAINE			
University of Maine	James D. McCleave	100,000	Modernization of Marine Biological Research Facilities
MARYLAND			
Morgan State University	Frederick W. Oliver	186,325	Renovation of the Science Complex
MASSACHUSETTS			
Marine Biological Laboratory	Harlyn O. Halvorson	575,000	Modernization of Lillie Research Laboratory
Massachusetts Institute of Technology	Philip M. Gschwend	700,000	Modernization of Environmental Science and Engineering Facility
Mount Holyoke College	Edwin S. Weaver	100,000	Renovation of Chemistry Research Laboratories
Worcester Polytechnic Institute	Robert N. Katz	175,000	Renovation of Ceramics/Power Metallurgy Processing Research Facilities

NATIONAL SCIENCE FOUNDATION ACADEMIC RESEARCH FACILITIES MODERNIZATION PROGRAM AWARDS

STATE	INSTITUTION	PROJECT DIRECTOR	AWARD	ACADEMIC RESEARCH FACILITIES MODERNIZATION PROJECT
MICHIGAN				
	University of Michigan - Ann Arbor	Henry N. Pollack	350,000	Research Facilities Modernization in Geological Sciences
	University of Detroit	Joseph V. Swisher	200,000	Research Area Renovation in Chemistry Building
MINNESOTA				
	Macalester College	Elizabeth S. Ivey	350,000	Renovation of Research Facilities in Biology, Geology, and Psychology
	Winona State University	Steven P. Berg	74,484	Modernization of the Biology Research Laboratories
MISSISSIPPI				
	University of Mississippi	James L. Wyatt, III	889,260	Physics Research Facilities Modernization
MISSOURI				
	University of Missouri - Columbia	William R. Folk	1,449,728	Renovation and Replacement of Biochemical Research Facilities
NORTH CAROLINA				
	Duke University	Richard A. White	1,900,000	Systems Upgrade of the Biological Sciences Building
	University of North Carolina - Charlotte	Robert D. Snyder	200,000	Renovation of Smith Engineering Building
	University of North Carolina - Greensboro	Stephen R. Mosler	285,000	Behavioral and Life Sciences Animal Facility Renovation
NORTH DAKOTA				
	North Dakota State University	Gregory D. Gillispie	600,000	Renovation of Chemistry Facilities
NEW MEXICO				
	New Mexico State University	Lynford L. Ames	200,000	Renovation of Chemistry Research Facilities
	University of New Mexico	Diane L. Marshall	150,000	Renovation of Facilities for Integrated Research in Biology
NEW YORK				
	Barnard College	Paul E. Hertz	125,000	Renovation of Biology Research Facilities
	Canisius College	Edward C. Kisailus	664,513	Biology Research Facilities Renovation
	Columbia University	Alvin I. Krasna	700,000	Renovation of Facilities for Molecular Biophysics
	Ithaca College	John M. Bernard	375,000	Modernization of Plant and Invertebrate Research and Research Training Facility
	Rensselaer Polytechnic Institute	David A. Aikens	600,000	Upgrade of Cogswell Chemistry Laboratory Air Handling Systems
	Rockefeller University	David Baltimore	275,000	Relocation and Renovation of Protein Sequencing and Biopolymer Facilities
	SUNY College at Buffalo	Charles A. Beasley	350,000	Great Lakes Field Station Modernization Program
OHIO				
	Miami University at Oxford	T. William Houk	725,000	Renovation/Repair of Culler Hall Physics Research Facilities
OKLAHOMA				
	Oklahoma State University	George S. Dixon	800,000	Renovation and Modernization of Facilities for Materials Research
OREGON				
	Oregon State University	Douglas R. Caldwell	125,000	Renovation of Oceanography Laboratories
	Reed College	Douglas C. Bennett	816,000	Replacement of Chemistry Research and Research Training Laboratories
PENNSYLVANIA				
	Academy of Natural Science of Philadelphia	Samuel Gubins	200,000	Renovation of Inadequate Ventilation Systems in Biological Research Facilities
	Allegheny College	David E. Anderson	200,000	Renovation of Behavioral Research Facilities
	Carnegie Mellon University	Aksel A. Bothner-By	1,600,000	Renovation of Research Laboratories in Mellon Institute
	Penn State University - University Park	George J. McMurtry	825,000	Modernization of Fenske Chemical Engineering Laboratory
RHODE ISLAND				
	Brown University	Carol L. Wooten	660,000	Barus and Holley Building Engineering and Physics Modernization
TENNESSEE				
	Fisk University	John M. Springer, Jr.	800,000	Renovation of Chemistry/Physics Building
	University of Tennessee - Knoxville	James Q. Chambers	1,700,000	Renovation of Chemistry Research Facilities
TEXAS				
	Trinity University	Nancy S. Mills	288,650	Renovation of Chemistry Departmental Research Laboratories
	University of Houston - Clear Lake	Margaret R. Kasschau	125,000	Biology Facility Renovation
VERMONT				
	Saint Michael's College	Ronald H. Provost	375,000	Modernization of Cheray Science Hall
WASHINGTON				
	University of Washington	Robert J. Charlson	225,000	Renovation of Space for Global Change Research
WEST VIRGINIA				
	West Virginia University	Trevor M. Harris	180,000	Renovation of Geo-Data Processing Research and Research Training Laboratory
WISCONSIN				
	Beloit College	John R. Jungck	146,000	Renewal of Facilities for Research and Research Training in Biology
	University of Wisconsin - La Crosse	Thomas O. Claflin	120,000	Aquatic Toxicology and Chemistry Laboratory Renovation
	University of Wisconsin - Madison	Charles G. Hill, Jr.	600,000	Renovation of Chemical Engineering Laboratories
WYOMING				
	University of Wyoming	John W. Nishio	575,000	Replacement and Modernization of the Botany Glasshouse

The American Society of Mechanical Engineers

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March 24, 1992

The Honorable Rick Boucher
Chairman
House Science Subcommittee
2319 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Chairman:

The National Science Foundation (NSF) Task Force of the Council on Education of the American Society of Mechanical Engineers (ASME) respectfully requests that the enclosed statement be included in the record of the February 25 Science Subcommittee authorization hearing regarding the FY 1993 budget request of the NSF.

ASME is a worldwide engineering society focused on technical, educational, and research issues, with 118,000 members, including 21,000 students. This statement notes that for the first time the NSF Engineering Directorate budget request includes an increase to over ten percent of the total NSF budget and recommends that this positive trend be allowed to continue by setting a goal of moderate annual increases in the Engineering Directorate to reach 15 percent of the NSF budget by FY 2000.

We appreciate your consideration of our views.

Sincerely,

John R. Howell

John R. Howell
Chairman
NSF Task Force

Enclosure

The American Society of Mechanical Engineers

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Statement
on the
Fiscal Year 1993 Budget Request
for the
National Science Foundation

by the
Task Force on the National Science Foundation,
Council on Education
of the
American Society of Mechanical Engineers

Submitted to the
Subcommittee on Science
Committee on Science, Space, and Technology
U.S. House of Representatives

March 24, 1992

Mr. Chairman and Members of the Subcommittee:

We would like to submit the following statement on the fiscal year (FY) 1993 budget request of the National Science Foundation (NSF), on behalf of the NSF Task Force of the Council on Education of the American Society of Mechanical Engineers (ASME) for the hearing record for the NSF authorization. This statement represents the considered judgement of this task force, a group of engineers with expertise in the field, rather than an official position of ASME.

ASME is a non-profit educational and technical society of mechanical engineers. ASME was founded over 100 years ago, and today its membership exceeds 118,000 professionals in mechanical engineering, including over 20,000 students.

Engineering within NSF

Engineering education and research are at the heart of potential solutions for increasing the manufacturing competitiveness of the United States, reducing our energy dependence, eliminating toxic waste and acid rain problems, and indeed every technological challenge facing this country. NSF administers the leading federal programs for support of engineering education and basic research and we note that the Engineering Directorate has been slated to receive 10.3 percent of the proposed NSF FY 1993 budget. This Directorate is responsible for research support not only in mechanical engineering, but aerospace, civil, chemical, computer, electrical, nuclear, and petroleum engineering as well. This is the first time the budget proposal for the Engineering Directorate has included an increase to over ten percent of the total NSF budget and we applaud this action.

In order to continue this positive trend, we firmly believe that NSF should direct a greater portion of its funds to support engineering education and research, and we propose a goal of moderate annual increases to reach 15 percent of the NSF budget by FY 2000. A start has been made by the administration's proposal to provide the Engineering Directorate with an increase of 20.9 percent over the FY 1992 appropriation, which exceeds the overall average NSF requested increase of 17.9 percent.

It is vital to the national interest to maintain and increase our technology base and to provide the means to attack serious national problems that have a substantial technical component. They cannot be dealt with without a continuing supply of engineers and a strong engineering education and research base. The present minimal NSF funding in many engineering programs has very serious implications for the nation's future, particularly in light of the severe resource problems being faced by private and public universities.

Comments on NSF Priorities

Our evaluation of the FY 1993 NSF budget request suggests that priorities have been established within the NSF for advanced materials processing, biotechnology, high-performance computing and communications, and global warming. Emphasis is also placed in other areas of environmental research, manufacturing and plant sciences. We recognize the importance of these efforts, and it is indeed appropriate that federal R&D investments be directed to these national concerns. Funding for these R&D endeavors falls within the domain of several federal agencies, and we encourage continued and expanded interagency collaboration in order to assure that public investments in these cross-cutting disciplines have the greatest impact. We would caution, however, that the traditional NSF support for university research and education programs not be sacrificed in the process of directing scarce R&D resources to these broader program objectives.

Engineering Design Initiative

Many studies have shown that the critical issue in global competitiveness is translation of research results into competitive products in a timely manner. This process is a major part of engineering design, and engineers are at the very core of this process. The Manufacturing Studies Board of the National Research Council (NRC) was requested by NSF to determine the importance of engineering design to U.S. industry, and to propose and recommend mechanisms for improving engineering design practice, education, and research. In response, the Committee on Engineering Design Theory and Methodology was formed by NRC, and issued the report Improving Engineering Design: Designing for Competitive Advantage, National Academy Press, 1991. The report recommends that NSF propose and Congress fund an initiative for engineering design as the critical first step in significantly expanding the research base in engineering design.

Key elements of the initiative should be:

- to expand and emphasize the NSF Engineering Design Program by providing clear identity, strong leadership, and stable continuous funding at an initial level of $5 million, increasing in four years to $20 million annually;
- to establish an NSF Design Scholar Program which would allow university faculty and doctoral students to work for one or two years with a "best practice" engineering firm, followed by three years of NSF research support with matching industrial support; and
- to facilitate improved teaching of engineering design by establishing a clearinghouse for design instructional materials and methods.

We strongly recommend that the initiative in Engineering Design be added to the FY 1993 NSF budget. The budget request for the Design and Manufacturing Systems Program within the Engineering Directorate shows a 37.7 percent increase over the FY 1992 current plan, the largest increase of any program within the Directorate. We believe that this increase is appropriate, especially if directed toward the goal of expanding the Design Engineering Program as requested above.

The Design Scholar Program should be a designated program within the Graduate Education and Research Development activity of the Education and Human Resources Directorate. It is noted that this program has a large apparent funding increase over the FY 1992 current plan, but this increase is largely due to carryover of FY 1992 funds for graduate traineeships. There is no actual increase in appropriations requested for this program. We urge that the Design Scholar Program be funded by an additional appropriation of $1 million for FY 1993, increasing to $3 million in succeeding years.

In addition the NRC report recommends that NSF should join with the Department of Commerce to study the possible structure and operation of a National Consortium for Engineering Design (NCED). NCED would foster the improvement of design for competitive advantage through improving design practice, education, and research. Such a program would directly address the perceived U.S. difficulties in international competitiveness in manufactured products with a coherent program that brings together all interested parties, including industry, government, and academia. To initiate this effort, we recommend that NSF be specifically directed to be the lead agency in this effort; that this effort be housed within the Design and Manufacturing Systems Program of the Engineering Directorate; that NSF propose how NCED should best be implemented; and that NSF include a request for funding of NCED in the FY 1993 budget at an appropriate level. This latter request should include funds to carry out the proposed clearinghouse for design instructional materials and methods.

Academic Research Instrumentation

It is noted that funding for Academic Research Instrumentation and Facilities has been requested by NSF at the level of $33 million, devoted exclusively to Academic Research Instrumentation, with no request for funding in Research Facilities Modernization. We believe that this is appropriate, and that Congress should not redirect this funding to be split evenly between the programs as was done in FY 1992. Instrumentation in engineering and scientific research is becoming increasingly expensive, and the requested level of funding is quite small given overall national needs in this area. Facilities modernization can and should be the obligation of the institutions which gain a long-term benefit from such changes. It should be noted that instrumentation has a relatively short life due to technological obsolescence, but has a very large impact on the national ability to maintain leadership in engineering research. We urge that the NSF request for this item be left as submitted.

Education and Human Resources

Two items in the administration's proposed budget for Education and Human Resources stand out. One is the proposed reduction of 26.1 percent for Graduate Education and Research Development. This is apparently not a real reduction because of carryover for this item of $23 million from unexpended FY 1992 funds for graduate traineeships. However, it is urged that NSF award these traineeships during the FY 1993 budget cycle so that no further carryover occurs. The carryover indicates that the traineeship program was not fully implemented in FY 1992. In a time of reduced defense research spending, university support for graduate students from other research sources may strongly decline in FY 1993, and the NSF program can have a significant positive impact.

There is some concern at the 70.8 percent ($31.5 million) increase in the Systemic Reform program. $18 million of this increase is due to the transfer of the Experimental Program to Stimulate Competitive Research (EPSCoR) to the Systemic Reform Program from Research and Related Activities. An additional $1.5 million has been added to the EPSCoR Program for FY 1993. The Systemic Reform Program itself will increase by $11 million the major new funding (out of $14.5 million) in the Education and Human Resources Program. The Systemic Reform program has very important yet diverse goals, and its success would be an immense boost to engineering education by increasing the pool of qualified and interested students who could choose engineering as a career. However, it is an expensive program, and it will be extremely difficult to evaluate its effectiveness. We propose that NSF provide a careful method for evaluation of the success of this program and establish goals for such success, and be prepared to reevaluate the focus of the program if its present methods do not meet the standards.

Encouraging Trend

Aside from our serious concern with the overall level of funding for engineering education and research, we find some encouraging trends in other areas of the NSF proposed budget. In particular, the overall proposed increase of 17.9 percent over the current year plan will help toward the commitment to double the budget over a five year period. We appreciate this opportunity to present our views and recommendations on the FY 1993 budget for NSF.

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STATEMENT

By The

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS - UNITED STATES ACTIVITIES

To The

SUBCOMMITTEE ON SCIENCE
COMMITTEE ON SCIENCE, SPACE & TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

On The

FISCAL YEAR 1993 BUDGET REQUEST

For The

NATIONAL SCIENCE FOUNDATION

February 25, 1992

The Institute of Electrical and Electronics Engineers is the world's largest technical professional society with nearly a quarter of a million U.S. members engaged in advancing our nation's well-being through the development and application of a broad and growing range of electrotechnologies. IEEE's United States Activities Board (IEEE-USA) serves to promote the career and technology policy interests of that U.S. membership which is vitality concerned with our declining national competitiveness particularly in critical high technology industries.

The competitiveness of American industry -- and of the electronics industry in particular -- is of great concern to the IEEE-USA in light of forthcoming reductions in defense spending and the resulting displacement in the defense industrial sector. We feel that it is essential for all federal research and development programs to promote cooperation between government, industry, and academic researchers in developing new technologies and new products for American companies. Only if our American industry is competitive, with state-of-the-art products to sell, can it succeed in the global marketplace and create the wealth that is so necessary to meet our national needs.

For that reason, IEEE-USA supports the President's FY 1993 budget request of for the National Science Foundation which is consistent with a pledge to double the NSF budget by FY 1994. In particular, IEEE-USA supports increases targeted for NSF's research and related programs. Requested increases of 21 percent for Engineering and 29 percent for Computer and Information Science and Engineering will support important new research on High Performance Computing and Engineering, advanced materials and processing, and intelligent manufacturing that can make significant contributions to sustaining U.S. technological competitiveness.

IEEE-USA, 1828 L Street, N.W., Suite 1202, Washington, DC 20036-5104

While IEEE-USA recognizes and supports NSF's role in pure science, we wish to stress the importance of its recent efforts to couple academic engineering research with industrial needs, particularly through the Presidential Young Investigator (PYI) program, the Engineering Research Centers, the Science and Technology Centers, and the Engineering Education Coalitions. With regard to the two new young investigator programs designated the Presidential Faculty Fellows (PFF) and the NSF Young Investigator (NYI) awards that are replacing the Presidential Young Investigator awards, we would respectfully suggest that Congress request that NSF add a component to the PFF aimed at coupling academic research with industrial needs and the Congress also increase the number of NYI awards to a level commensurate with the earlier PYI program. The importance of government initiatives that assist young engineering faculty to establish their on-campus research programs and that encourage them to work with industry cannot be overstated.

We also endorse the Industry-University Cooperative Research Program and NSF's activities in sponsoring summer industrial work/intern opportunities for engineering faculty members. We urge Congress to fund programs like these in full and to encourage NSF to provide opportunities for industry-university cooperation through programs in all directorates -- not just engineering. We also encourage Congress to broaden the terms under which industrially-sponsored academic research projects qualify for partial NSF funding, particularly by allowing and encouraging NSF to match in-kind support from companies.

Recognizing that the competitiveness of American industry requires a well-trained and educated work force, IEEE-USA supports NSF's efforts in improving scientific and technologies literacy at all levels, particularly K-12. We also endorse its goal of attracting talented youth to careers in engineering, science, and mathematics, and we encourage Congress to fund programs that support this goal.

IEEE-USA is concerned about the handling of funding for the U.S. Antarctic Research Program in recent years. The respective roles of NSF and the Department of Defense in supporting Antarctic Research need to be clearly defined to prevent the end-of-year budget juggling that has resulted in across the board cuts to NSF's research programs in each of the last two years.

In conclusion, we thank you for this opportunity to present our views on the FY 1993 budget request for the National Science Foundation. IEEE-USA and its Engineering R&D Policy Committee stand ready to assist you as a resource for technical advice and policy perspectives on NSF's important science and engineering programs.

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