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ABSTRACT

This document presents a transcript of the hearing on the present state and future directions of the National Science Foundation (NSF) and the state of science and mathematics education in the United States. Testimony was presented by the director of the NSF and the deputy assistant direction of Education and Human Resources at NSF. The witnesses discussed: (1) the NSF's responsibilities in relation to the challenges the nation is facing today in the areas of international competitiveness, global change, the environment, energy, and education; (2) the fact that solutions to these problems will require new knowledge created through research; (3) the importance of continued collaboration among industries, the education community, and state and Federal Government to successfully further science and engineering education and develop the necessary human resources in these areas; (4) examples of where successful research has taken place as well as NSF's budgetary needs in order to continue to supply adequate support to research efforts; and (5) the competitiveness of the United States with the rest of the world in the area of research in mathematics and science education. Copies of the prepared statements are included, and questions and answers submitted for the record are appended. (MDH)

POSTURE OF NATIONAL SCIENCE FOUNDATION

HEARING

BEFORE THE

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

ONE HUNDRED SECOND CONGRESS

FIRST SESSION

APRIL 11, 1991

[No. 9]

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*Ranking Republican Member.

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WITNESSES

POSTURE OF NATIONAL SCIENCE FOUNDATION

THURSDAY, APRIL 11, 1991

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

The Committee met, pursuant to call, at 2:40 p.m., in Room 2318, Rayburn House Office Building, Hon. George E. Brown, Jr., [Chairman of the Committee] presiding.

The CHAIRMAN. The Committee will come to order.

We hope a few more members will be coming in, but in the meantime, we have the usual opening statements, which I think we would like to present, and then we will hear from our distinguished witness.

It is a great pleasure today for me to welcome Dr. Walter E. Massey, the National Science Foundation's new Director to his first appearance before the Science, Space and Technology Committee.

Dr. Massey brings to his new position a distinguished record of achievement as a scientist and educator and an administrator. He's a member of the National Academy of Sciences and has been President of the American Association for the Advancement of Science, Director of the Argonne National Laboratory, as well as Vice President and Professor of Physics at the University of Chicago.

Dr. Massey is a former member of the National Science Board and comes to his new position with a broad knowledge of the Foundation's programs and goals.

In a recent interview with the Washington Post, Dr. Massey named a few of his priorities for the Foundation: improved math and science education for all Americans; continued focus on areas of research with potential value for the private sector; adequate funding for research within the traditional academic framework and increased cooperation between U.S. and foreign scientists.

Dr. Massey, the Committee shares your concern about the state of math and science education in our Nation and we support the Foundation's efforts to bring about substantive reforms in our educational structure. We also recognize NSF's role in enhancing our technological competitiveness and my understanding is that the subcommittee will be holding hearings on that aspect of the NSF's work in the near future, and at the same time, we recognize NSF's role in maintaining an appropriate balance between support for directed and undirected basic research.

There are many signs that U.S. science is stressed by the need to adjust to changing circumstances. We intend to look into the stress and the circumstances in coming months.

Because of the importance of NSF to the overall health of U.S. science, I'm sure that we will have a continuing dialogue with you.

We welcome you today and we look forward to this opportunity to become better acquainted with your views on a range of issues confronting NSF and becoming acquainted with your vision for the future of the Foundation.

Now let me turn to our ranking Republican member, my good friend, Mr. Packard, from California.

[The prepared opening statement of Mr. Brown follows:]

OPENING STATEMENT
NATIONAL SCIENCE FOUNDATION
POSTURE HEARING
OF THE
HON. GEORGE E. BROWN, JR. (D-CA)
CHAIRMAN
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
ON

April 11, 1991

It is a great pleasure today to welcome Dr. Walter E. Massey, the National Science Foundation's new Director, to his first appearance before the Science, Space, and Technology Committee.

Dr. Massey brings to his new position a distinguished record of achievement, as a scientist, an educator, and an administrator. He is a member of the National Academy of Sciences, and has been President of the American Association for the Advancement of Science, Director of Argonne National Laboratory, as well as Vice President and Professor of Physics at the University of Chicago.

Dr. Massey is a former member of the National Science Board, and comes to his new position with a broad knowledge of the Foundation's programs and goals.

In a recent interview with the Washington Post, Dr. Massey named as a few of his priorities for the Foundation: improved math and science education for all Americans; continued focus on areas of research with potential value for the private sector; adequate funding for research within the traditional academic framework; and increased cooperation between U.S. and foreign scientists.

Dr. Massey, the Committee shares your concern about the state of math and science education in our Nation, and we support the Foundation's efforts to bring about substantive reforms in our educational structure. We also recognize NSF's role in enhancing our technological competitiveness, while at the same time maintaining an appropriate balance between support for directed and undirected basic research.

There are many signs that U.S. science is stressed by the need to adjust to changing circumstances. We intend to look into the stress and the circumstances in coming months. Because of the importance of NSF to the overall health of U.S. science I am sure we will have a continuing dialog.

We welcome you today, and we look forward to this opportunity to become better acquainted with your views on a range of issues confronting NSF, and with your vision for the future of the Foundation.

Mr. PACKARD. Thank you, Mr. Chairman, and I, too, would like to join with the rest of the members of this Committee in welcoming Dr. Massey, not only to this hearing, but to NSF as its administrator. We're delighted. He gave me the privilege and the honor of visiting my office earlier this week and we had a chance to sit down and personally visit and get better acquainted, for which I'm grateful.

Certainly, I'm looking forward to working with you, Dr. Massey, and you certainly do come, as the chairman mentioned, with great credentials and impressive background in research and academics and administration and we're interested this afternoon in hearing about the areas that come under the Foundation's purview. These include funding for individual investigators, the balance to be struck between big science and little science, the relationship between basic research and applied science, and the promotion of U.S. industrial competitiveness. Another issue which the Science Subcommittee will be conducting hearings on this month is indirect cost composition of federally funded university research.

So, Dr. Massey, I look forward to hearing your vision of what you see in the future for science in this country and for the National Science Foundation and how we can work together to achieve the goals and the objectives that you have, as well as this Committee. So I'm delighted to welcome you and appreciate the opportunity to work with you. Thank you.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Packard follows:]

STATEMENT OF
THE HONORABLE RON PACKARD (R-CA)
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
NSF POSTURE HEARING
2:30 P.M., 2318 RHOB
APRIL 11, 1991

I WOULD LIKE TO THANK THE CHAIRMAN OF THE FULL COMMITTEE FOR SCHEDULING THIS HEARING. IT IS IMPORTANT THAT WE DEVELOP A GOOD WORKING RELATIONSHIP WITH THE NEW NSF DIRECTOR, DR. WALTER MASSEY. AT THIS TIME I WOULD LIKE TO WELCOME DR. MASSEY WHO HAS AN IMPRESSIVE BACKGROUND IN RESEARCH, ACADEMICS AND ADMINISTRATION.

WE ARE INTERESTED IN HEARING ABOUT MANY AREAS THAT COME UNDER THE FOUNDATION'S PURVIEW. THESE AREAS INCLUDE FUNDING FOR INDIVIDUAL INVESTIGATORS, THE BALANCE TO BE STRUCK BETWEEN BIG SCIENCE AND LITTLE SCIENCE, THE RELATIONSHIP BETWEEN BASIC RESEARCH AND APPLIED SCIENCE, AND THE PROMOTION OF U.S. INDUSTRIAL COMPETITIVENESS. ANOTHER ISSUE WHICH THE SCIENCE SUBCOMMITTEE WILL BE CONDUCTING HEARINGS ON THIS MONTH IS INDIRECT COST COMPOSITION OF FEDERALLY-FUNDED UNIVERSITY RESEARCH.

DR. MASSEY, I LOOK FORWARD TO HEARING YOUR VISIONS OF THE FUTURE OF THE NATIONAL SCIENCE FOUNDATION AND HOW WE CAN WORK TOGETHER TO INTEGRATE THE GOALS OF NSF WITH THE AGENDA OF THIS COMMITTEE.

The CHAIRMAN. Thank you, Mr. Packard.

Let me recognize Mr. Boucher, who is the chairman of the Science Subcommittee, for any statement he may have.

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

I am also pleased to join with you and the gentleman from California, Mr. Packard, in welcoming Dr. Walter Massey, the new Director of the National Science Foundation, as our witness this afternoon.

As a former Director of the Argonne National Laboratory, and given his other extensive experience, Dr. Massey brings a wealth of expertise to this critical position.

As the nation faces increasingly strong international competition in both science and technology, and in the development of new commercial products and services, Dr. Massey will provide a firm hand at the National Science Foundation.

I was very pleased that in the fiscal year 1992 budget submittal, the administration is recommending a 17.5 percent increase in funding for the National Science Foundation. That is an amount sufficient to put the budget back on track to achieve a doubling of the budget by 1994 beginning with 1987 as the base year. Within that budget request, there are promising new initiatives in High-Performance Computing and Communication, the U.S. Global Change Research Program, material synthesis and processing and in the field of education and human resource development.

On February the 20th of this year, the Science Subcommittee met with the Acting Director of the NSF, Dr. Frederick Bernthal, and with Dr. Mary Good, the Chairman of the National Science Board. At that time, we discussed the programs and priorities that are contained in the fiscal year 1992 administration budget request, as well as various aspects of the NSF's current activities.

In subsequent hearings on March the 12th and 13th, we received comments from nongovernmental witnesses on that range of subjects. Today, I'll be very pleased to learn of Dr. Massey's priorities for the National Science Foundation and, in particular, I would welcome a statement of his views as to where the balance should be placed among a number of competing priorities within the NSF's purview, including the support for investigators, the new instrumentation initiative and the modernization of laboratory space, all of which I think we will concede are important needs.

Since the NSF's mission spans both science and technology and technology is a key to international competitiveness, I also hope that during the course of the statement today, Dr. Massey will comment on the appropriate level of support that is needed to strengthen the nation's technology base and to forge appropriate linkages between industry and academia.

Mr. Chairman, I join with you in welcoming Dr. Massey, both to this hearing and to his role as Chairman of the National Science Foundation.

[The prepared opening statement of Mr. Boucher follows:]

OPENING STATEMENT
OF THE
HONORABLE RICK BOUCHER (D-VA)
CHAIRMAN, SUBCOMMITTEE ON SCIENCE
ON
POSTURE HEARING ON THE
NATIONAL SCIENCE FOUNDATION

April 11, 1991

I am very pleased to join Chairman Brown in welcoming Dr. Walter E. Massey, the new Director of the National Science Foundation (NSF) as our witness at this hearing. Dr. Massey, a former Director of the Argonne National Laboratory, brings with him extensive academic and administrative experience. As the nation faces increasingly strong international competition in science and technology, and in the development of new commercial products and services, we need a firm hand at the helm of the National Science Foundation to lead our country to a bright future as we approach the 21st century.

We are pleased that the President's budget proposal for NSF contains an increase of 17.5%, and places the Foundation back on the track for a doubling of its 1987 budget by 1994. Within that budget request, we support the important initiatives in High-Performance Computing and Communication, the U.S. Global Change Research Program, Materials Synthesis and Processing, and Education and Human Resource Development.

On February 20, 1991 the Science Subcommittee met with the Acting Director, Dr. Frederick Bernthal, and Dr. Mary Good, Chairman of the National Science Board (NSB). At that time, we discussed the programs and priorities contained in the President's FY92 budget, as well as various aspects of NSF's current activities. In the subsequent March 12, and 13 1991 hearings, non-governmental witnesses commented on the NSF budget and its program priorities.

We are vitally interested in the future direction of the Foundation's priorities. Where will the balance be placed for support of principle investigators, instrumentation, and modernization of laboratory space, which may be particularly important for accommodating newly acquired laboratory instrumentation?

Since NSF's mission spans both science and technology, and technology is a key to international competitiveness, how will NSF provide the appropriate support to strengthen the nation's technology base and to forge linkages between industry and academe?

Our country needs greater scientific literacy, and a continuing cadre of bright scientists and engineers. NSF funding for scholarships, grants and fellowships, and support for programs to revitalize science education in the schools are essential for our nation's long term prosperity. How will NSF address these needs in an era of possible diminishing federal funding?

At this time we are pleased to have the opportunity to learn more about your vision of the economic and scientific future of our nation and the role of NSF to strengthen our international competitive edge.

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The CHAIRMAN. Thank you very much, Mr. Boucher.

Mr. Fawell, would you care to make an opening statement?

Mr. FAWELL. Yes, I would.

Basically, I just feel very proud, coming from the great State of Illinois, and Dr. Massey, of course, is a University of Chicago physicist and, as has been stated, he was a Director at Argonne National Laboratory for a number of years and I know of no one in this great nation of ours who could better fill the shoes of the—as head of the National Science Foundation, than the distinguished man from the University of Chicago, and I personally—I don't think I've gotten to see you face-to-face to congratulate you. I look forward to your tenure at the National Science Foundation and look forward to your testimony also.

The CHAIRMAN. Thank you very much, Mr. Fawell. Illinois does have a great deal to be proud of and I'm sure that they will get a fair share of NSF grants—

[Laughter.]

Mr. FAWELL. I was, Mr. Chairman, going to mention the fact that we're very happy with five NSF science and technology centers in Illinois and we really don't look for any more, but if they were forced upon us, we might accept one or two more.

[Laughter.]

The CHAIRMAN. All right.

[The prepared opening statements of Messers. Costello and Bruce follow:]

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OPENING STATEMENT BY U.S. REP. JERRY F. COSTELLO
ILLINOIS

COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

NATIONAL SCIENCE FOUNDATION POSTURE HEARING
APRIL 11, 1991

Mr. Chairman, today we welcome our very distinguished witness, National Science Foundation Director Dr. Walter E. Massey. I look forward to hearing Dr. Massey views about his plans and priorities for NSF.

One area that I am particularly interested in discussing with Dr. Massey is the state of precollege science education in the United States today. Since coming to Congress I have heard a great deal about the sorry state of math and science education in our country, and I have also heard a great deal about a new commitment to change this situation. I am sure with Dr. Massey's extensive background in teaching that he will be able discuss in detail his goals for NSF in these areas.

Mr. Chairman, I look forward to hearing our witness today, and I thank you for calling this hearing.

OPENING REMARKS
THE HONORABLE TERRY L. BRUCE
WELCOMING OF DR. MASSEY TO NSF
APRIL 11, 1991

THANK YOU, MR. CHAIRMAN. I WOULD LIKE TO TAKE THIS OPPORTUNITY TO WELCOME DR. MASSEY.

DR. MASSEY HAS DEVOTED HIS CAREER TO SCIENCE IN MANY AREAS, INCLUDING TEACHING AND RESEARCH. FURTHERMORE, HE IS A LONG TIME RESIDENT OF ILLINOIS THROUGH HIS WORK AT ARGONNE NATIONAL LABORATORY, THE UNIVERSITY OF CHICAGO, AND IN MY DISTRICT AT THE THE UNIVERSITY OF ILLINOIS IN CHAMPAIGN-URBANA. HIS EXEMPLARY SERVICE IN ALL CAPACITIES HAS BROUGHT HIM TO US HERE TODAY AS THE NEW DIRECTOR OF NSF. I LOOK FORWARD TO WORKING WITH YOU, DR. MASSEY, IN YOUR NEW POSITION.

THANK YOU.

The CHAIRMAN. Dr. Massey, we'd like to welcome you again, as I said, and you may proceed with your testimony in whatever way you think will be desirable.

STATEMENT OF DR. WALTER E. MASSEY, DIRECTOR, NATIONAL SCIENCE FOUNDATION; ACCOMPANIED BY JANE T. STUTSMAN, DEPUTY ASSISTANT DIRECTOR, EDUCATION AND HUMAN RESOURCES, NATIONAL SCIENCE FOUNDATION

Dr. MASSEY. Thank you very much, Mr. Chairman. Is this on? Yes. Thank you very much, and thank all of the members for those kind welcoming comments.

Mr. Chairman, members of the Committee, it's a pleasure to appear here before you today for my first time as Director of the National Science Foundation. I look forward to many opportunities to work with the committee as we try to tackle the challenges that lie ahead.

As we begin this process of collaboration, it is important to remember the mutual commitments that have been made by the administration and the Congress with respect to the National Science Foundation. Congress has identified research and education as high priorities worthy of increased investments, despite a constrained fiscal environment. The Foundation, in turn, is committed to investing the resources entrusted to it in an effective and socially responsible manner.

This is a commitment that I take very seriously. President John F. Kennedy stated this principle best in his address to the National Academy of Sciences on the occasion of its 100th anniversary. I quote: He said, "Scientists alone can establish the objectives of their research, but society, in extending support for science, must take account of its own needs."

Viewed in this light, NSF's responsibilities are considerable. Our nation is facing a number of significant challenges, including international competitiveness, global change, the environment, energy, education and others. These challenges, as diverse as they are, do share a common theme, and that is, their solutions will require new knowledge, created and applied through science and engineering research and education, as well as the effective application of what we learn.

Furthermore, solutions will often require close collaboration among industries, universities and the Federal and State Governments. In each of these respects, the National Science Foundation can provide significant and lasting contributions.

The Foundation meets these responsibilities in a number of ways by emphasizing a commitment to excellence in the programs developed and the projects supported, by developing human resources, broadening participation in education and research and improving science and engineering education and by strengthening the science and engineering research base and infrastructure.

These responsibilities are, of course, inseparable and together, they form the basis for finding scientific and technological solutions to competitive challenges and society's other needs. These responsibilities also require constant attention to ensure that an appropriate balance is struck between research and education, be-

tween large and smaller-scale activities, and between the disciplines whose boundaries are constantly shifting and blurring.

The vitality of science and engineering requires not only resources, but also skilled scientists and engineers, trained workers and a scientifically literate and supportive public.

In this regard, we need to raise both the quality of science and engineering education and the quantity of people knowledgeable of these fields, and these issues are very much related. Too often, many science courses fail to appeal to broad sections of the population, and as a result, interest in scientific and technical careers among American students is continuing to fall, despite a growing demand for scientists and engineers and a surge of excitement in many fields.

Our system has brought us to the point, unfortunately, that in 1980s—in the '80s, the decade of dramatic breakthroughs in superconductivity, genetics, computing and many other areas, we are witnessing a decline in the number of American citizens receiving Ph.D.s in science and engineering.

These dual problems of educational quality and quantity are most acute for those groups that have been historically under-represented in science and technology. Although these populations are becoming more important in our society as a whole, they still have very low rates of participation in the critical areas of science and engineering. Only 8 percent of the bachelor's degrees and 4 percent of the Ph.D.s in science and engineering are awarded to Blacks and Hispanics and these numbers have not changed significantly in a very long time.

While the numbers of high school and college-age women interested in these fields have been growing, they are still only fractions of their male counterparts. These figures, coupled with a decline in the size of total college-age population and in the face of increased demand for scientists and engineers, are an item of serious concern for the nation now and in the future.

Despite these problems, because I don't want to appear overly pessimistic, there are reasons to be optimistic, if only cautiously optimistic. All sectors of our society, including businesses, universities, governments and individual citizens are responding to the need to improve education, especially at the pre-college and undergraduate levels.

Innovative partnerships are being forged to maximize the unique strengths of different participants. For example, with NSF support, the local Chamber of Commerce in Huntsville, Alabama, is working to provide a number of mobile laboratories equipped and staffed by industry scientists and engineers to help bring laboratory experiences to local area high schools where these facilities are lacking.

Here in Washington, D.C., at Howard University, the Foundation supports an effort aimed at improving the quality of science teachers in local area high schools, as well as increasing the number of minority students who elect to pursue careers in science and engineering.

I'm also pleased that the spirit of collaboration exists between the Foundation and Congress. Congress, and particularly this committee, has strongly supported the NSF's activities in science and

engineering education, which all of you mentioned in your opening remarks. In addition, legislation passed last year, the Excellence in Science, Mathematics and Engineering Education Act, provides an important framework for addressing problems at every educational level and in both formal and informal settings.

Through my service over the past year on the President's Council of Advisors on Science and Technology, I am also convinced through this and other means that this administration will continue to give strong support in this area and I'm looking forward to working with this committee and the rest of Congress to sustain the momentum that is developing behind improved—improvements in education.

Concerning support for research, the challenges we face are of a somewhat different nature. Unlike in science and math education, especially at the pre-college level, the United States is clearly still the world leader in basic research and graduate education. For that reason and others, it is imperative that we maintain our leadership in this area, while at the same time more skillfully and expeditiously attempting to exploit opportunities to realize the practical benefits of our leadership in this area of research and education.

Unfortunately, much of the recent attention to research and research activities has been somewhat negative. Questions about accountability and openness, such as indirect costs, merit review and scientific fraud and misconduct have become front-page news in many major newspapers and in the television. These issues are serious and they deserve our attention. They do little to bolster the public's appreciation for the critical role colleges and universities play in research and education.

But I would submit that these problems should not be allowed to detract from the vital contributions made by our colleges and universities towards the well-being of the country through the people educated and trained and the new knowledge developed at these institutions.

America's colleges and universities are a unique and critical national asset. By combining research and education, these institutions provide a setting for the conduct of basic research and for the training of future scientists and engineers that is unparalleled in the world. Students are able to hone their understanding and often are the source of new ideas as they work with experienced teachers and researchers.

During my recent sabbatical in Europe, I gained a new perspective on how our system looks from the outside and I can tell you from that perspective, U.S. basic research remains the standard of excellence worldwide.

The benefits of basic research are clear and substantial. Basic research provides the foundation for scientific and technological progress and these, in turn, translate into solutions to complex challenges facing our society. This is clearly the case in national competitiveness. One can recite numerous examples. One of the most striking to me was triggered by the recent death of Nobel Laureate John Bardeen. It is noteworthy that in his lifetime, his invention, the transistor, virtually revolutionalized worldwide industry and worldwide societies.

Indeed, there is scarcely any aspect of our lives which has not been touched by this invention and it's only been in the lifetime of one individual.

Technological progress and, hence, competitiveness in important areas continues to be fueled by advances in basic research. For example, one outgrowth of research in semiconductors and integrated circuitry is nanofabrication, the creation of micromachines, smaller than a human—than the width of a human hair. Scientists at Virginia Polytechnic Institute, working with those at Dow Chemical, have prepared substances that can separate small molecules from large molecules and can help to provide new ways to improve our efficiency in a number of activities.

Remaining competitive requires, however, continuing investments in research and education. This is something our international competitors have learned all too well. For over a decade now, Germany and Japan, in particular, have been increasing their investments in civilian research and development, as measured against our Gross National Product, while we, on the other hand, in the United States, when measured in these same terms, have remained essentially unchanged.

In 1988, Germany and Japan dedicated approximately 2.7- and 2.9 percent of their national resources to nondefense R&D, while we allocated only about 1.9 percent of our GNP to this area.

During the same decade, America's leadership position in technology-intensive markets has steadily declined. I would submit that these trends are not unrelated.

On the positive side, our nation is responding to these concerns. Industry, universities and governments, both at the Federal and State levels, are increasing their investments in research and equally important, these sectors are collaborating more and more in areas of mutual benefit, making the most effective use of our scarce natural resources.

A good example of collaboration among university researchers, industry and the National Science Foundation is in the area of computer networking. In one project, researchers from Los Alamos National Laboratory, the University of California's San Diego Supercomputer Center, the Jet Propulsion Lab at Cal Tech and industrial collaborators, including MCI, Pacific Bell and US West, with support from the Foundation as well as DARPA, are collaborating on research into very high-speed networking, an area of intense interest to this Committee. The outcome of this research is, of course, very much related to our national competitive position.

Let me just say a few words about our budget submission for this year. As Congressman Boucher has said, this is a very good budget for the agency and one I am very pleased to have inherited.

Since your Subcommittee has already had an extensive discussion of this subject only a brief while ago, I will only mention a few of the major items in the budget for FY 1992. As you know, I did not participate in the development of this budget, but after having been on board for only a month or so as Director, I must say I am extremely pleased, not only with the size of the proposed increase, but with the balance and the sense of priorities contained within the agency's proposals for 1992.

We request 2.72 billion, a 17.5 percent increase over 1991, and as mentioned earlier, if affirmed and passed by the House, and the Senate, this would put us back on the track to doubling the NSF budget, a goal of both the administration and the House and the Senate.

Education and human resources is an important area for all of us and here the Foundation's mission, I think, is well-recognized. This area represents that fastest-growing portion of our budget, in fact, and as part of an interagency mathematics and science education initiative, coordinated by the FCCSET process; that is, the Federal Coordinating Council for Science, Engineering and Technology, we are proposing to increase support for all programs related to education and human resource development by 23 percent in this budget. This will bring the total effort in the Foundation to almost a half billion dollars, 456 million.

This includes activities scattered throughout the Foundation, not just in the Directorate primarily responsible for those activities.

Included among the highest priorities in this area are programs to encourage more women, minorities and disabled students and other under-represented parties to participate more fully in our scientific and technological enterprise. We are requesting almost $100 million for these efforts in 1992. That is roughly a 25 percent increase above 1991.

In the pre-college math and science arena, we will be emphasizing teacher preparation and teacher enhancement activities.

Particular attention will be directed to working more closely with State Governments and educational agencies through a significant expansion of the Statewide system reform initiative to improve educational quality and achievement for all students. This particular program represents somewhat of a new approach for the Foundation in the management of its education and human resource programs and I'm sure we'll discuss that more, later.

We are attempting in this program to stimulate a wholesale change in the way States approach math and science education in a systematic way, and hoping that this approach may turn out to be useful for other programs in the area of education and human resource development.

In the area of research and infrastructure, we are requesting an approximately 17 percent, 16.9 percent increase for support of research and scientific equipment, which would bring the total to nearly $2 billion in 1992. Double-digit increases are requested for every research directorate. I believe that this budget sets the right set of priorities, as I said earlier, and reflects the appropriate balance that must be struck between all the difficult choices that must be made.

For example, in this budget, a 12 percent increase is aimed primarily at strengthening programs for individual investigators and small research groups. With these resources, the Foundation expects to support 29,000 scientists and post-doctoral students in 1992. We will also augment the research and education capabilities of the Science and Technology Centers, as well as the Engineering Research Centers, but as you know, we do not intend to start any new centers in this budget cycle.

We will also substantially emphasize new and continuing research initiative. Many of the—most of these initiatives, in fact have come through the FCCSET process, which has worked very well from my perspective. The High-Performance Computing and Communications initiative, the U.S. Global Change research program—as well as within the Foundation, the new initiative on Material Synthesis and Processing—will all have potentially broad effects and a major impact on our national competitiveness.

But research requires not only skilled scientists and engineers, but also the tools to enable them to conduct cutting-edge research. Therefore, we are requesting $50 million to undertake a Presidential initiative to support academic research instrumentation. This initiative will provide the kind of large and expensive research equipment that is needed for America's academic laboratories, increasing access to and use of these sophisticated instruments.

This initiative, along with the existing NSF programs, will bring our total support for scientific equipment and instrumentation to almost $400 million, $392 million, in FY '92, which is a 35 percent increase over 1991.

While these budgetary proposals are impressive, the fact remains, as you know and have pointed out, that universities, school and industries continue to outstrip NSF's ability to provide adequate support. I should have said demands from these institutions outstrip our ability to provide adequate support.

Given the scarcity of resources, I believe that we at the Foundation should concentrate on those activities that respond to the most important and pressing needs of the research community; that is, research support, instrumentation and equipment, as well as specialized facilities, and for that reason, as you know and have pointed out to us, we are not requesting funds this year for the Academic Research Facilities Modernization program. And we can speak more about that later, of course.

In the area of competitiveness, just last month, the Council on Competitiveness, a private-sector organization, released a report entitled, "Gaining New Ground: Technology Priorities for America's Future." In that report, top industrial R&D leaders from across the country identified five categories of generic technologies that will drive U.S. productivity, economic growth and competitiveness during the next decade. These categories are: materials and the associated process and techniques, engineering and production technologies, electronic components, information technologies and power train and propulsion technologies.

Of these five categories, information technologies was the only one these experts consistently ranked the U.S. position as strong or competitive.

What is the source of our strength in this area? The Council concluded that America's strong competitive advantage is related to four factors. First, close ties between basic research and the generic technology development. Second, active individual innovation. Third, strong government support, and fourth, a high level of private-sector R&D funding. The Council also found that industry, other industries where we are still strong also share these characteristics, biotechnology, software and computer-aided engineering, to name a few.

These are all areas or factors which are supported through programs by the National Science Foundation.

The NSF's contributions to competitiveness are also rooted in its support for research, as well as education, and in the nature of its interactions with universities, industry and other organizations. We understand that merely funding research and education projects is not necessarily enough to improve competitiveness. It is also important that we stimulate productive collaborations between the providers and the users of research.

For example, at the Engineering Research Center for Intelligent Manufacturing Systems at Purdue University, a unique and outstanding environment has been created for research, education and industrial collaboration on advanced concepts for a next generation of computerized and responsive manufacturing systems, and in the next six years—in the six years, I should say, since this center was established, companies such as Alcoa, Chrysler, Cincinnati Milacron, as well as Cummins Engines, have made use of the research results generated by this center for their own industrial collaboration. This kind of collaboration is becoming an increasingly common feature in the centers supported by the National Science Foundation, not only in manufacturing and engineering, but in areas such as computer science and biotechnology.

However, I think we all recognize that above all else, our ability to retain our competitive edge will be dependent upon the continuing development of our human resources and a commitment to improve math and science education at all levels.

Well, let me just say a few remaining words about some issues, as I see them, in science and education. The NSF and the nation as a whole has many successes in research and education, but we cannot afford to rest on our laurels. I think in particular, attention must continue to be focused on the following issues: First, and I repeat this because I feel very strongly about it, nowhere else in the world is there a substitute for the setting at United States colleges and universities, a setting that encourages young scientists and engineers to explore new ideas and challenges—and also to challenge the work of more senior researchers, an environment that promotes intellectual freedom, stimulates creativity, and contributes to economic growth.

Our basic research enterprise, particularly within our universities, must not be allowed to weaken. Graduate education must remain a high priority. The United States is the world leader in basic research and graduate education and we must make that a continuing effort of ours to see that we do not slip in this area.

But while maintaining our strength in this area, it is equally important that we focus on improving science and engineering education at the elementary, secondary and undergraduate levels. The President and the governors have established a set of goals for the nation to achieve by the year 2000, and the National Science Foundation has a particularly crucial role to play, not only in providing direct support through its programs, but also by exerting leadership and stimulating constructive change.

The natural linkages that exist between research and education must be strengthened. Too often, the myth that these are separate and distinct activities has obscured their respective importance.

Both education and research are essential to—are essential and inseparable functions of our universities and colleges. Both provide the Foundation for our future standing as a technology—technologically competitive nation.

Is that the hook? I'll finish in a minute.

Participation in science technology and science education by those groups and regions of the country that have not fully developed the benefits must also be increased. This includes raising the historically low participation rates of women, minorities and disabled individuals in science and engineering careers. The challenges that we face here are national in scope and, therefore, we must commit national resources to solving them.

Collaboration. More will be required among industry, universities, the public sector and from foreign nations. Effective collaboration stimulates the timely application of research results to society's needs while offering the added benefits of identifying new sources of funding.

Priorities, programs and methods of support within the Foundation also need to be constantly re-evaluated to ensure that we are identifying and stimulating new and potentially promising areas of research and human resource development.

The Foundation must continue to be an active partner in interagency mechanisms to improve the effectiveness of Federal programs. Working through FCCSET and other means, NSF must continue to search for ways to improve coordination and collaboration with other Federal agencies.

Finally, the National Science Foundation has and must continue to work with the scientific and engineering research community to address the full range of accountability issues. The public has a right to expect that its resources are used effectively and efficiently.

In conclusion, Mr. Chairman, I recognize that the National Science Foundation has a responsibility to serve the research and educational needs of the society that has entrusted its resources to us. The programs and activities described above represent sound investments in the future and the people and the knowledge base that will enable our nation to respond to the many challenges it faces today.

With the support of this Committee, this request, I hope, and the benefits it will bring to our country can become a reality.

Mr. Chairman, I thank you for this opportunity to testify before the Committee and I would be pleased to answer any questions that you or your colleagues might have.

[The prepared statement of Dr. Massey follows:]

TESTIMONY OF DR. WALTER MASSEY

DIRECTOR, NATIONAL SCIENCE FOUNDATION

BEFORE THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

APRIL 11, 1991

Mr. Chairman, members of the committee, it is a pleasure to appear before you today for my first time as the Director of the National Science Foundation. I look forward to many opportunities to work with the Committee as we try to tackle the challenges that lie ahead.

As we begin this process of collaboration, it is important to remember the mutual commitments that have been made by the Administration and the Congress with respect to the National Science Foundation. Congress has identified research and education as high priorities, worthy of increased investments despite a constrained fiscal environment. NSF, in turn, is committed to investing the resources entrusted to it in an effective and socially responsible manner. This is a commitment that I take very seriously. President John F. Kennedy stated this principle best in his address to the National Academy of Sciences on the occasion of its one-hundredth anniversary:

> ". . . scientists alone can establish the objectives of their research, but society, in extending support for science, must take account of its own needs."

Viewed in this light, NSF's responsibilities are considerable. Our Nation is facing a number of significant challenges, including international competitiveness, global change, the environment, energy, education, and others. These challenges, as diverse as they are, share a common theme: their solutions will require new knowledge, created and applied through science and engineering research and education, as well as the effective application of what we learn. Furthermore, solutions will often require close collaboration among industries, universities, and the federal and state governments. In each of these respects, NSF can provide significant and lasting contributions.

NSF meets these responsibilities in a number of ways: by emphasizing a commitment for excellence in the programs developed and the projects supported; by developing human resources, broadening participation in education and research, and improving science and engineering education; and by strengthening the science and engineering research base and infrastructure. These responsibilities are inseparable and together form the basis for finding scientific and technological solutions to competitive challenges and society's other needs. These responsibilities also require constant attention to ensure that an appropriate balance is struck between research and education; between large and smaller scale activities; and between disciplines whose boundaries are constantly shifting and blurring.

Education and Human Resources

The vitality of science and engineering requires not only resources but also skilled scientists and engineers, trained workers, and a scientifically literate and supportive public. Moreover, we need to raise both the quality of science and engineering education and the quantity of people knowledgeable of these fields. These issues are, of course, interrelated. Too often, science courses fail to appeal to broad sections of the population. As a result, interest in scientific and technical careers among students is continuing to fall, despite a growing demand for scientists and engineers and a surge of excitement in many fields. Our system has brought us to the point that the 1980's -- the decade of dramatic breakthroughs in superconductivity, genetics, computing, and many other areas -- witnessed a decline in the number of American citizens receiving Ph.D.s in science and engineering.

The dual problems of educational quality and quantity are most acute for those groups that have been historically underrepresented in the sciences. Although these populations are becoming ever more important in our society, they have very low rates of participation in the critical areas of science and engineering. Only 8% of the bachelor's degrees and 4% of the Ph.D.s in science and engineering are awarded to Blacks and Hispanics, while the numbers of high school and college-aged women interested in these fields are only fractions of those of their male counterparts. These figures, coupled with a decline in the size of the total college-age population in the face of growing demand for scientists and engineers, should be of serious concern with regard to our modern work force -- and our Nation -- in the near future.

Despite these problems, there are reasons for cautious optimism. All sectors of our society -- including businesses, universities, governments, and individual citizens -- are responding to the need to improve education, especially at the precollege and undergraduate levels. Innovative partnerships are also being forged to maximize the unique strengths of different participants. For example, with NSF support, the local area chamber of commerce in Huntsville, Alabama is working to provide a number of mobile laboratories, equipped and staffed by industry scientists and engineers, to help bring laboratory experiences to local area schools that lack such facilities. At Howard University, NSF is supporting an effort aimed at improving the quality of science teaching in area high schools as well as increasing the number of minority students who elect to pursue careers in science and engineering. This

particular partnership activity will call on the services of minority scientists, engineers, and public officials to communicate to young people the importance of science education.

I am also pleased to see that the spirit of collaboration exists between NSF and Congress. Congress, particularly this Committee, has strongly supported the Foundation's activities in science and engineering education. In addition, legislation passed last year, the "Excellence in Science, Mathematics, and Engineering Education Act," provides an important framework for addressing problems at every educational level and in both formal and informal settings. My service on the President's Council of Advisors on Science and Technology has convinced me that this Administration will continue to give strong support to this area, and I look forward to working with this Committee and the rest of Congress to sustain the momentum behind educational improvement.

Support for Research

The challenges we face in research are of a different nature. The United States is clearly the world leader in basic research and graduate education. It is imperative that we maintain our leadership in these areas, while at the same time, more skillfully and expeditiously exploiting opportunities to realize the practical benefits of this research.

Unfortunately, much of the recent attention given to research has been negative. Questions about accountability and openness such as indirect costs, merit review, and scientific fraud have become front page news in many major newspapers. These issues are serious and deserve our attention. They do little to bolster the public's appreciation for the critical role colleges and universities play in research and education. However, these problems should not be allowed to detract from the vital contribution made by our colleges and universities towards the well-being of the country through the people educated and trained and the new knowledge developed at these institutions.

America's colleges and universities are a unique and critical national asset. By combining research and education, these institutions provide a unique setting for the conduct of basic research and for the training of future scientists and engineers. Students are able to hone their understanding and are often the source of new ideas as they work with experienced researchers. From my recent sabbatical in Europe, I know that our system of basic research remains the standard of excellence worldwide.

The benefits of basic research are clear and substantial. Basic research provides a foundation for scientific and technological progress, which, in turn, translates into solutions to complex challenges. This is clearly the case in national competitiveness. For example, the first transistor was invented by Nobel Laureate John Bardeen, who passed away only a short time ago. Within his lifetime, Dr. Bardeen's inspiration revolutionized computing, communications, and electronics. Indeed, there is scarcely any aspect of our lives that has not been touched by and benefitted from this invention.

Technological progress, and hence competitiveness, in important areas continues to be fueled by advances in basic research. For example, one outgrowth of research in semiconductors and integrated circuitry is nanofabrication, the creation of "micromachines" smaller than a human hair. Scientists at the Virginia Polytechnic Institute and Dow Chemical, have prepared a clay-like substance that can separate small molecules from large ones. This molecular sieve can help increase the yield of gasoline from a barrel of oil or help separate and purify drug compounds. In the long-term, these and other applications of nanofabrication research may be as significant as those that followed transistors and integrated circuits.

Remaining competitive requires continuing investments in research and education. Our international competitors have learned this lesson all too well. For over a decade, Germany and Japan have been increasing their investments in civilian research and development, as measured against their gross national products, while the U.S. investment, when measured in the same terms, has remained essentially unchanged. In 1988, for example, Germany and Japan dedicated 2.7% and 2.9% of their national resources to non-defense R&D; the U.S. only 1.9%. During this same decade, America's leadership position in technology-intensive markets has steadily declined. These trends, I believe, are not unrelated.

On the positive side, our Nation is responding to these concerns. Industry, universities, and governments, both at the federal and state levels, are increasing their investments in research. Equally important, these sectors are collaborating more and more in areas of mutual benefit, making the most effective use of their scarce resources. A good example of collaboration between university researchers, industry and the Foundation is reflected in the computer networking area. Here researchers from Los Alamos National Laboratory, University of California San Diego Supercomputer Center, Jet Propulsion Laboratory, Cal Tech; and industrial collaborators including MCI, Pacific Bell, and US Westat--with support from NSF and the Defense Advanced Research Projects Agency--are collaborating on research into very high speed networking. The outcome of research such as this is directly related to the implementation of the High Performance Computing and Communications initiative. While we have begun to make some progress, much work remains ahead.

NSF's FY 1992 Budget Request

The National Science Foundation's budget request reflects the agency's commitment to help alleviate national concerns by investing in promising areas of research and education. Since your Subcommittee has already had an extensive discussion on this subject only a short time ago, I will only briefly describe some of the major plans for FY 1992.

As you know, I did not participate in the development of this budget, but after having been on board for the past month as the Director, I am very pleased with the balance and sense of priorities contained within the agency's proposals for FY 1992. The NSF budget requests $2.72 billion in FY 1992, a 17.5% increase over the 1991 level. This increase reaffirms the

goal established by the President and supported by Congress to double the Foundation's budget by 1994.

Education and Human Resources. The Foundation's mission to strengthen education and human resources represents the fastest growing portion of NSF's budget. As part of an interagency mathematics and science education initiative coordinated by the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET), NSF is proposing to increase its support for all programs related to education and human resource development by 23% in FY 1992, bringing the total effort to $456 million. (This includes the educational activities supported by the research directorates.)

Included among the NSF's highest priorities are programs to encourage more women, minorities, and disabled students, and other under-represented parties to participate more fully in our scientific and technological enterprise. NSF is requesting almost $100 million for these efforts in FY 1992, roughly a 25% increase above the 1991 level. In the precollege math and science education arena, NSF will be emphasizing teacher preparation and enhancement activities.

Particular attention will be directed at working more closely with state governments and educational agencies through a significant expansion of the Statewide Systemic Reform initiative to improve educational quality and achievement for all students. This particular program represents something of a new approach for NSF in the management of its education and human resource programs. This program is attempting to stimulate a wholesale change in the way states approach math and science education in a systematic way. This approach may turn out to be useful for other programs in the education area.

Research and Infrastructure. NSF is requesting a 16.9% increase in its support for research and scientific equipment, bringing the total to nearly $2 billion in FY 1992. Double-digit increases are requested for every research directorate. I believe that this budget sets the right set of priorities and reflects an appropriate balance that must be struck between all the various choices that must be made.

A major 12% increase is aimed primarily at individual investigators and small research groups. With these resources, NSF expects to support roughly 29,000 scientists and postdoctoral students. NSF also plans to augment the research and educational capabilities of existing Science and Technology Centers and Engineering Research Centers but does not intend to start any new centers in 1992.

FY 1992 will also mark substantial emphasis on several new and continuing research initiatives. Working with other federal agencies through FCCSET, NSF will begin a new emphasis on High Performance Computing and Communications, while greatly expanding its support for the U.S. Global Change Research Program. In addition, NSF will begin a new initiative in Materials Synthesis and Processing, which will have a potentially significant impact on competitiveness.

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Research requires not only skilled scientists and engineers but also the tools to enable them to conduct cutting-edge research. Thus, NSF is requesting $50 million to undertake a Presidential initiative to support academic research instrumentation. This initiative will provide the kind of large and expensive research equipment that is needed for America's academic laboratories, increasing access to and use of these sophisticated instruments. This initiative, together with other NSF programs, will bring NSF's total support for scientific equipment and instrumentation to $392 million in FY 1992, a 35% increase over FY 1991.

While these budgetary proposals are impressive, the fact remains that demands from universities, schools, and industries continue to outstrip NSF's ability to provide adequate support. Given this scarcity of resources, I believe that NSF should concentrate on those activities -- research, instrumentation and equipment, and major specialized facilities -- that responds to the most important and pressing needs of the research community. It is for this reason that the Foundation is not requesting any funds in FY 1992 for the Academic Research Facilities Modernization Program.

Competitiveness. Just last month, the Council on Competitiveness, a private sector organization, released a report entitled "Gaining New Ground: Technology Priorities for America's Future." In that report, top industrial R&D leaders from across the country identified five categories of generic technologies that will drive U.S. productivity, economic growth, and competitiveness during the next decade. These categories are: materials and associated processing techniques; engineering and production technologies; electronic components; information technologies; and powertrain and propulsion technologies. Of these five, information technologies is the only one in which the experts consistently ranked the U.S. position as strong or competitive.

What is the source of the U.S. strength in this area? The Council concluded that America's strong competitive advantage is related to four factors: (1) close ties between basic research and the generic technology development, (2) active individual innovation, (3) strong government support, and (4) a high level of private R&D funding. Moreover, the Council found that industries in which the United States remains strong -- biotechnology, software, and computer aided-engineering, to name a few -- share these common themes. All four factors are promoted through support of the Foundation and its programs.

NSF's contributions to competitiveness are rooted both in its support for research and education and in the nature of its interactions with universities, industry, and other organizations. The Foundation understands that merely funding research and education projects is not necessarily enough to improve competitiveness. It is equally important to stimulate productive collaboration between the providers and users of research. For example, at the Engineering Research Center for Intelligent Manufacturing Systems at Purdue University, a unique and outstanding environment has been created for research, education and industrial collaboration on advanced concepts for a next generation of computerized and responsive manufacturing systems. In the six years since this center was established, companies, such as ALCOA, Chrysler, Cincinnati Milacron and Cummins

Engine, have made use of the research results generated by this center for their own industrial applications. This sort of collaboration is an increasingly common feature in NSF programs--not only in manufacturing engineering, but in other areas such as computer science and biotechnology.

However, above all else, our ability to regain our competitive edge will dependent upon the continued development of our human resources and a commitment to improve math and science education at all levels.

Major Issues In Research and Education

NSF has had many successes in research and education, but it cannot afford to rest on its laurels. In particular, attention must continue to be focused on the following issues:

- Nowhere in the world is there a substitute for the setting at U.S. colleges and universities -- one that encourages young scientists and engineers to explore new ideas and challenge the work of more senior researchers; one that promotes intellectual freedom, stimulates creativity, and contributes to economic growth. Our basic research enterprise, particularly within our universities, must not be allowed to weaken. Graduate education must remain a high priority. The United States is the world leader in basic research and graduate education and must continue to be so.

- While maintaining our strengths in graduate education, it is equally important that we focus on improving science and engineering education at the elementary, secondary, and undergraduate levels. The President and the Governors have established a set of goals for the Nation to achieve by the year 2000. NSF has a particularly crucial role to play, not only by providing direct support through its programs but also by exerting leadership and stimulating constructive change.

- The natural linkages that exist between research and education must be strengthened. Too often, the myth that these are separate and distinct activities has obscured their respective importance. Both education and research are essential and inseparable functions of our universities, and both provide the foundation for our future standing as a technologically competitive Nation.

- Participation in science, technology, and science education by those groups and regions of the country that have not fully enjoyed their benefits must be increased. This includes raising the historically low participation rates of women, minorities, and disabled individuals in science and engineering careers. The challenges that we face are national in scope; we must, therefore, commit our national resources to their solution.

- Collaboration among industry, universities, the public sector, and foreign nations must be encouraged. Effective collaboration stimulates the timely application of research results to society's needs, while offering the added benefits of identifying new sources of funding.

- Priorities, programs, and methods of support must be constantly reevaluated to ensure that the National Science Foundation is identifying and stimulating new and potentially promising areas of research and human resources development. The reality of resource constraints must not be allowed to dampen the creativity and innovation within the research and educational communities.

- NSF must continue to be an active partner in interagency mechanisms to improve the effectiveness of federal programs. Working through FCCSET and other means, NSF must continue to search for ways to improve coordination and collaboration with other federal agencies.

- Finally, NSF has, and must continue, to work with the scientific and engineering research community to address the full range of accountability issues. The public has a right to expect that its resources are used efficiently and effectively.

Conclusion

Mr. Chairman, I recognize NSF has a responsibility to serve the research and educational needs of the society that has entrusted its resources to it. The programs and activities described above represent sound investments in the future -- in the people and the knowledge base that will enable our Nation to respond to the many challenges it faces today. With the support of this Committee, that request -- and the benefits it will bring to our country -- can become a reality.

Mr. Chairman, I thank for this opportunity to testify and I would be pleased to answer any questions you or your colleagues may have.

The CHAIRMAN. Thank you very much, Dr. Massey. You've covered a broad scope of materials here.

Let me focus first on the statistics that you quoted with regard to the comparison between the Japanese and the U.S. investment in research and development. You indicated that the Japanese were investing 2.9 percent of their Gross National Product and the United States was investing 1.9. That would seem to indicate that just to catch up with the Japanese, we'd have to increase by about 50 percent, measures as percent of the GNP.

Could you do a quick calculation and sort of tell us what that would mean in dollars?

Dr. MASSEY. Well, I would—we are investing now about 158 billion totally. Of that two-thirds, about, goes into defense-related. We put about half of that defense-related into R&D. I would say about another 70 billion, maybe 65, 70—

The CHAIRMAN. Just another 70 billion.

[Laughter.]

The CHAIRMAN. And, of course, that doesn't—that doesn't take cognizance of the fact that the Japanese rate of increase has been about a doubling every—

Dr. MASSEY. I'm sorry, I was using total, not just Federal.

The CHAIRMAN. I understand that. I understand that. The figures are total, which about half are government and half are private.

Dr. MASSEY. Exactly, sorry.

The CHAIRMAN. So maybe it's only 35 billion of government expenditures and another 35 billion in private expenditures. The Japanese ratio is even heavier weighted toward private investment than government, weighted more so than the United States.

So if we consider that investments in R&D are a reasonable measure of our scientific capability and our technological competitiveness, we have a little ways to go to catch up here.

Dr. MASSEY. In terms of funding. As a proxy for that, certainly, yes.

The CHAIRMAN. You've been keeping these statistics, incidentally, for the last 10 or 15 years, as I recall, and the statistics have been consistent in showing that the Japanese rate of growth in investment has consistently exceeded ours and even if we set the goal of catching up with them in five years, they would be even further ahead at that point because their rate of growth is greater.

Dr. MASSEY. Certainly, that is, of course, true, if we both kept—if they kept the same rate of growth.

The CHAIRMAN. I'm not asking you to suggest how we should address this problem. I'm just—I want the record to reflect that we have a ways to go here.

Dr. MASSEY. True.

The CHAIRMAN. You made some reference to a new initiative in materials synthesis and processing and that happened to be high in my mind because of a story that appeared last week, that the cost of producing solar energy might be reduced by as much as one-third by a new device using ordinary silicone rather than the more refined silicone that we've been using for solar cells. It is strictly a problem in materials processing and synthesis. It involves the use of silicone globes, small spheres. I should say, embedded in an alu-

minum matrix which turns out to be very productive in terms of solar energy.

So I would say, first, that your new initiative is very well timed and well taken. I am concerned, however, and I will just ask you this as a question, are we providing adequate resources at the present time for materials research across the board, not just at NSF, but as far as you know, Federal support through whatever agencies are supporting it?

Do you have at your fingertips any feeling for this—the level of support?

Dr. MASSEY. I don't remember the exact numbers. There was a very exhaustive—I shouldn't say exhaustive—a comprehensive report that came out of the National Research Council last year that looked at just this question of support of materials across all agencies and I think it was like 1.-some billion. What was that number? About 1.2 billion, that's right, across all agencies, and then—about a third—about 300 million—330 million is in the NSF.

The major actors in this are DOE, Department of Defense, and the National Science Foundation.

I wouldn't want to comment on whether total funding for materials research is adequate broadly. I think what this Committee pointed out, and other groups have pointed out, that in terms of translating the results of that research into competitive activities, that the missing factor is in the area of synthesis and processing, whereas the United States has a very strong base in the basic materials research and the understanding of the properties of materials. Where we have been weak, it is felt, is in the area of how one synthesizes new materials to meet specific needs and the processing of those in an industrial sector to lead to new products and that is what this new initiative will focus on, that myth, that centerpiece.

The CHAIRMAN. Well, it's appropriate in light of the recommendation that you cited from the Council on Competitiveness, which—but as the first of five technologies, materials and associated processing techniques.

I would assume that this would be—encompass some of the initiatives that you're proposing in the Foundation.

Dr. MASSEY. Yes.

The CHAIRMAN. I don't want to belabor—I don't want to appear to be nit-picking about the need for resources here in light of what we all recognize is a very generous administrative budget—administration budget. I do, however, feel the need to try and put this in perspective as it relates to how far we have to go if we are going to regain the leadership that we have enjoyed in past years and which I think we probably lost in the last 10 years.

Let me ask just one additional question, and this is just for information, not in any way intended to be critical. You have, in the NSF budget, funding for a program known as LIGO, Laser Interferometer Gravitational-Wave Observatory. Apparently, this did not fall within the purview of the Astronomical Survey Committee and I don't know whether it fell within the purview of any physics review groups or not, and I would just like to inquire as to how you reached the determination to make this a new start and I'm sure that this is going to come up again in other hearings, and I am asking for my personal edification.

Dr. MASSEY. It will come up, no doubt, at other hearings. For a project in the NSF budget, it is a large construction project, of course, and that's one reason appropriately that Congress and others want to understand it better. It became a high priority through a very long process, a process that is typical of the way NSF sets it priorities.

As you know, as an agency, we depend heavily on the advice of the community that we serve and we don't set the priorities from Washington, not even the Science Board does, but try to respond to the needs of the community as the scientists and engineers see them themselves.

This project did come out of a very comprehensive look at the needs of the physics community. It came through the physics advisory committees of the NSF. It was ranked as one of the highest projects by a special group chaired by Dr. William Brinkman of Bell Labs, or the Brinkman report. This was recognized and recommended as a very high priority. It then went through the other advisory groups, reviewed extensively by the National Science Board and, on balance with other activities in the Foundation, you know, made the cut as one of those to be highly recommended. It has very broad-based support in the Foundation and on the Science Board, as is indicated by its being resubmitted again, even though it didn't get funding last year.

With respect to the astronomy report, the Bahcall report that you are referring to, I have spoken with the members of that committee, and especially Dr. Bahcall himself. They did not rank it because they were looking at instruments that could be used for astronomical measurements in the next decade.

This device—I don't think anyone expects—unless they are very lucky—would be at a point to be used as an astronomical device to do measurements for the astronomical community. It is a device now in its initial stages to look for gravitational waves, to verify the existence all theoretical calculations and as indirect evidence that they do exist.

This should detect them. When it does, and is refined sufficiently enough to be able to detect them with some precision, then it could be—reach a stage where it could be used as an astronomical instrument.

So I think the explanation is that in the time scale over which this committee was ranking projects, it was not in their purview.

The CHAIRMAN. I very much appreciate that response. That was a test question to see if you had really grasped all the intricacies of the NSF budget process.

I would like to turn to Mr. Packard now.

Mr. PACKARD. Thank you, Mr. Chairman.

One of the unique opportunities of a change in leadership in an organization is the opportunity it gives to reevaluate where we've been going and what our priorities are and what programs we may wish to discontinue and what programs need to be enhanced and funded beyond what we've been in the past and perhaps some new programs that the new administration has had on their agenda for some time before coming to leadership.

You're in that unique position, Dr. Massey. I'd be interested to hear what you foresee or if you've been able to start the process of

analyzing where we've been; what's working; what needs to be enhanced and what new programs you'd like to initiate.

Dr. MASSEY. Well, I haven't had sufficient time for myself to do all of that, but I—I was somewhat familiar with the Foundation, being on the Science Board and other advisory committees. So I don't come without knowing something about it.

Unfortunately, for many people, not here, out there, who expect me to come in and make a great number of changes, the Foundation is working very well and the programs we support are those that I feel quite appropriate to the Foundation. So I do not come to this position with any immediate notions of radical change in direction or programs.

I think I'm left by the previous director and the administration and with your support with a very good agency and a very good set of programs. There are those I would emphasize more or less over the next year and we will be developing new programs.

I think what we need to look at now is appropriate balance, one across the various areas of activities, from our initiatives, directed programs and centers and the like, and the support of individual investigators—I should say investigator-initiated research, which can be some—a little different.

Also, I hope that we can maintain our flexibility. I think this has been one of the strengths of the Foundation and it's a very valuable asset because the needs of the scientific and engineering community change because science and engineering are fields that—in which things can change very rapidly due to new breakthroughs and we need to be able to respond to those.

There's also a growing interest and we all recognize a need to make the connection where we can between the research and the needs of the nation in developing human resources and competitiveness. Now, that connection will not be direct in all areas of our programs and I don't think we should try to force it in every area, but we should make sure that in those areas where it is appropriate.

And, also, in those areas where it is appropriate, I think we should—we will begin to look more at the outcomes of our investment and in all areas, that is not quite appropriate. In areas of basic research, our job is to support the best research among the best researchers and the outcome is often unpredictable. But in the areas of, say, education and human resource development, where we have initiated programs and in areas where we have programs to stimulate competitiveness, we will begin to see how we put in place systems to evaluate how well we are doing in those areas.

So those are my thoughts initially at this point.

Mr. PACKARD. Thank you, Mr. Chairman, I have no further questions.

The CHAIRMAN. Mr. Boucher.

Mr. BOUCHER. Thank you very much, Mr. Chairman, and Dr. Massey, I want to congratulate you on an excellent opening statement and it confirms what I suggested in my opening statement and that is that the NSF is in very good hands as you begin your tenure.

I was somewhat concerned when I observed in the administration's budget request the absence of any funding for research facili-

ties. There's an authorization at the present time of $250 million for the upcoming fiscal year for that item and there very clearly is a large national need.

Our subcommittee had testimony from a number of university research administrators, as well as bench scientists, who talked about the inadequate state of facilities, their crowded nature, their discrepant condition, and in fact, at one point, the statement was made that even if new instrumentation were provided to these facilities through your new instrumentation initiative, that many of the buildings were in such poor repair that they technically could not accommodate them. Some of these buildings, apparently, are in such decrepit condition that the rain comes in and you certainly don't want to be putting very expensive new instrumentation in those buildings. Some of the buildings simply can't accommodate them.

I'm wondering, first of all, if you have any comment about the intentions that you would have in the coming years with respect to NSF recommendations to OMB with regard to research facilities modernization. And secondly, whether, assuming that funding is provided through the appropriations process for your new instrumentation initiative, whether some of the funds from instrumentation might be spent in order to adequately maintain buildings so that the instrumentation can be effectively housed?

Dr. MASSEY. With respect to the problem as a whole, I recognize it myself, just coming recently from the academic and research community, and I don't think—I know that the fact that this is not in the budget this year in no way means that the Foundation or the administration is not cognizant of this need. I think it's the reverse, in fact, that it was the feeling that given the magnitude of the problem in this area, that the amount of funds available in this budget would really not go very far in addressing the problem, and also in conversations—and not just conversations, feedback from the scientific community, it's clear that instrumentation is another very pressing problem, along with facilities.

Given the trade-offs and the amount of money likely to be available, the conclusion was reached—and I strongly support it—that the way to make the quickest impact on the scientific community in terms of the infrastructure with the $50 million was to focus on the instrumentation area, and especially an area with very difficult a price range for many institutions to avoid—afford instruments from about $200,000 to a million or more.

So that was the reasoning behind this and it fits the general priorities on criteria for the Foundation and the support of people, research, instrumentation and facilities. So I think that was a wise decision.

The problem hasn't gone away. We will have to address it, the President's Science Advisor, Dr. Bromley, and I. He's discussed it with other—heads of all the agencies and we will be working together to try to come up with some comprehensive approach to the problem.

With respect to your specific suggestion of whether these funds might be used in a way to help the schools rehabilitate the places where the instruments are put, I think that's a distinct possibility. We have now a small group working in the Foundation putting—

drawing up the criteria and guidelines and, as you know, cost-sharing will be required and what I've asked them to look at is there any way to package this so that the cost-sharing might, in fact, be—come though that—this kind of action.

Mr. BOUCHER. So, in other words, if the university were to spend money from non-Federal sources for the upgrade of the buildings, that might satisfy the cost-sharing requirement with respect to your instrumentation grant?

Dr. MASSEY. We're certainly looking at that as one possibility.

Mr. BOUCHER. Okay.

You have in the FY '92 budget, new initiatives for High-Performance Computing, for Materials Science and Engineering, for Global Climate Change, for the National Education and Research High-Performance Computing Network and I'm wondering if you could look ahead for the next three years and give us some indication of whether you think adequate funding is going to be forthcoming to sustain those initiatives without eating into the base of the NSF's regular programs?

Dr. MASSEY. That's a very—very important question, and we, of course, look—are looking at that. I would like to look ahead a few years and say, yes, adequate funding will be available. Of course, not all of that is within my purview. These initiatives are very important. They're very good for the nation.

The process by which they've been generated may be as important, in fact, as the particular initiatives that emerged from them because they have the Federal agencies working together coordinating and utilizing Federal resources in a very efficient—and I think it's going to be a much more effective way, not just the dollars, but bringing together people and this will bring together people in the research and technology community, also.

The question will be how many initiatives can we afford to undertake, the pace of funding them, and a balance between those initiatives and the core programs for supporting individual researchers. We don't want our entire budget to be tied up in predetermined research activities because the life blood of the Foundation, of course, is those new ideas that are generated by the scientific community.

The budget plan now, as it's projected, I think, is sound and sensible if we can get the funding from it through the administration and with your support.

Mr. BOUCHER. Do you have any indications in your discussion with the Office of Science and Technology Policy that there is a continued commitment on their part, an intention on their part to request funding for these initiatives during the coming three years?

Dr. MASSEY. Yes, oh, yes.

Mr. BOUCHER. Okay.

I guess a corollary to that question is, can you give us any indication now of what new initiatives the NSF may be proposing in the next year or years thereafter? Or is it too soon to ask you that question?

Dr. MASSEY. It's too soon for me. We are looking at a number of areas. I, myself—there have been task forces in place within the Foundation and the FCCSET process is just beginning. The full

committee has not met, in fact, this cycle, nor the subcommittee that I would chair, so that process of looking at what new initiatives will be recommended to the OMB has not really—it's not far enough along yet.

Mr. BOUCHER. All right.

We have in the current NSF authorization, a mechanism whereby we are hoping that we can be apprised of what those new initiatives will be on a regularized basis and the mechanics by which we ask for that is for budget projections to be made by the NSF for coming years.

That process hasn't worked very well. What we look at, frankly, is a flat landscape when we see your budget projections. I think what might be helpful is if, on an ongoing basis, as the NSF reaches decisions to request funding for new initiatives, that you apprise us of that as rapidly as you can. I think that would be helpful for us. It would keep us better on track with the undertakings that you have on your agenda.

I have one additional question and then a comment and the question is simply this: I understand that there's a great deal of interest, perhaps some within the NSF, some within the Congress, some within the community at large, in having a new directorate established in the NSF for the social and behavioral sciences. There is a committee, as I understand it, at the NSF at the present time evaluating the appropriateness of establishing that new directorate.

I wonder if you have any comments today about the status of that committee's work, perhaps a comment on the substance of what that committee will recommend and, if not that, perhaps a prediction of when the report will be forthcoming.

Dr. MASSEY. Okay. The report is delayed, and frankly, I'm not sure why and our director of that—Assistant Director for BBS, Dr. Klauda, is out of the country. It was due last week, a couple of weeks ago, should be coming in. I have not seen it myself, I can say on that one.

I know they're devoting a great deal of time to the recommendation. I have no preconceived opinions. I have no position on the issue of whether or not a new directorate makes sense. I want to see the arguments pro and con and, you know, we will evaluate them.

Mr. BOUCHER. That makes two of us.

Dr. MASSEY. Okay.

Mr. BOUCHER. We can expect that report reasonably soon, though, based on—

Dr. MASSEY. I think—I'm sure we can. June 1st, I am told.

Mr. BOUCHER. June the 1st, all right. We'll be back in touch.

Dr. Massey, I simply want to say that I greatly appreciate your attendance here today, congratulate you on your position and look forward to working with you and your staff as we embark on these many challenging areas. Our subcommittee has a terrific cooperative relationship with the National Science Foundation and in the short time that I have served as chairman of the subcommittee, I've seen evidence of that fact.

We are working now on legislation that will give the NSF new powers and responsibilities with regard to environmental protection activities in the Antarctic and dealing with the emerging prob-

lem of the interface between tourism and other activities on that continent. We're beginning our hearings very shortly on the question of indirect costs and university research with the goal not so much of identifying problems, but searching for answers. We'll look forward to your participation in that process.

Then we'll have hearings following that of the role of science research and U.S. competitiveness and we would welcome testimony from you or your designee at the NSF on that issue as well.

It's a pleasure having you here today. Thank you for your thoughts and we'll look forward to working with you.

Thank you, Mr. Chairman.

Dr. MASSEY. Thank you.

The CHAIRMAN. Thank you very much, Mr. Boucher.

Mr. FAWELL. Thank you, Mr. Chairman.

I have just one area of inquiry. You have—you have testified that the NSF is proposing to increase its support for all programs related to education and human resource development by 23 percent in fiscal year 1992, bringing the total to 456 million, and you've also indicated that in the pre-college math and science education arena, NSF will be emphasizing teacher preparation and enhancement activities.

Several—oh, about, I guess over a month ago, we had a meeting back in my district with the Educational Advisory Committee and we had a number of high school physics teachers there and we discussed the problems in that regard, though they were—they greatly acclaimed the work that both Argonne and FERMI have been doing insofar as science and math education is concerned.

One person, who has won several awards, is an outstanding high school physics teacher and his weird science techniques and things of this sort, which is of great interest to young people, is geared to attract young people into science and engineering—made the statement that the summer scholarship program of the National Science Foundation of the '60s and then it was phased out in the early '70s, was of immense help in allowing a number of middle school and high school teachers to be able to go on and get their graduate degrees in science and math, and he lamented the fact that that died out and he pointed out that a number of his colleagues, 10, 12 years down the line, will be retiring and there's been nothing to take the place of what he felt was a tremendously successful program.

He did have praise for the—for the teacher preparation and educational programs that help, but he brought out the point that if you don't really know your subject matter, you're not going to be able to teach well.

I was just wondering if you have looked at—I talked to several people at the National Science Foundation who have been very helpful, indicating that perhaps two years down the line, they may be going back to offering these scholarship programs so that you—you can increase the substantive education of your science and math teachers, but nothing really right away, yet it seems to me it's a good jolt of some money there and perhaps that would be a very fine program.

Have you had an opportunity at all to think about this subject or to talk with anybody at the National Science Foundation about it?

Dr. MASSEY. Oh, yes, and I was very much involved in those myself during those days and they were—they were very good. I ran one of those programs myself at Brown.

The programs here will have that same aim, allowing science and math teachers at all levels to increase their subject matter, disciplinary strength, not necessarily directly through a scholarship to attend any particular school, but through participating in programs that—what are going to be centers for that activity.

So I think many of these programs will have the same end and the same effect, but it may not be packaged in exactly the same way, but they have the same goal and that is to allow the teachers to learn the subject matter that they will be teaching with emphasis on that, rather than all the emphasis on pedagogy.

Mr. FAWELL. Would they be picking up graduate degrees?

Dr. MASSEY. I don't know.

Ms. STUTSMAN. The achievement of a degree is not the primary goal of our teacher-enhancement programs. It is possible, even under the present guidelines, for that to be the goal of specific institutes, but it is not the primary goal of the program.

They were very successful in the '60s and '70s, as you have pointed out, and the present set of institute-like activities that we have have been developing in cooperation with teachers and schools of education, schools of science and they involve more than just subject matter, although that is the core, as Dr. Massey has pointed out.

They are aimed also at helping the teacher to go back to their school and have a support system so that they can really implement the things that they are learning in their institute-like activities, which, unfortunately, was missing in many of the earlier programs.

Dr. MASSEY. I think one—if I could continue—one of the—not drawbacks, but unfortunately, consequences of the programs in the '60s is that many of the teachers who did get a graduate degree did not go back to the schools, because—and when they did go back, the environment was not—hadn't changed very much, so their ability to really affect the system was limited and the new programs are really trying to address both of those kinds.

Mr. FAWELL. I know and I very much appreciate the answers. There were three high school teachers there and one middle—junior high school teacher—and they all had attested to the—they call came back—they all had attested to the—but they did mention that that was a bit of a—

Dr. MASSEY. Right.

Mr. FAWELL. —but they seemed to feel that the fact that one could obtain one's graduate degree—that was an enhancement to and I guess they felt that that was important and that there was perhaps more of an emphasis upon—more of an education course and enhancements than—I mean, in terms of procedures, how to teach, rather than substantive educational courses.

But it is—they impressed me very much because they are very successful and dedicated leaders in the field and, as I said, both FERMI and Argonne, with their programs. They are very much involved there, too, so they are certainly contributing greatly. When they leave, I'm not sure how you replace people like that.

Thank you. I just say the summer scholarship programs, at least I heard nothing but praise for it and lament that they had ceased in the early '70s.

Mr. FAWELL. Thank you, Mr. Chairman, that's all.

The CHAIRMAN. Thank you very much, Mr. Fawell.

Mr. Kopetski.

Mr. KOPETSKI. Yes, good afternoon, Mr. Chair. How are you?

The CHAIRMAN. Fine, thank you.

Mr. KOPETSKI. Dr. Massey, I certainly want to congratulate you on your new position.

Dr. MASSEY. Thank you.

Mr. KOPETSKI. I'm a new member of Congress. The Chair of this Committee is a new chair of this Committee and so I feel like we all have something in common, and the Chair and I would tell you that there's a lot of folks helping us succeed in our new positions, and I'm sure that there'll be a lot of folks in this committee as well who want you to succeed because it'll make a more enlightened America and with a lot of bright stars out there and I guess one of the—the question area I have for you is to get a feeling from you about the new faculty that we need in our universities and colleges.

I come from Oregon and we've got a great research institution with Oregon State, and it seems to me to that it's real tough as we are in this era of limited dollars for the new faculty to compete successfully for grants and research programs and I was wondering if, you know, there might be some thought out there for set-aside programs for the new faculty. We kind of jump-start them into the research fields and help them get established and get some labs and some instrumentations and programs going.

Any comments you have on that would be greatly—greatly appreciated.

Dr. MASSEY. NSF has programs to do that. Of course, I agree with you. It's very difficult for new faculty, new researchers to achieve funding and the NSF recognizes that and has programs, research initiation grants for young faculty or first-time faculty, and in fact, they're even some—we have the Presidential Young Investigators for the new faculty who come through that process and that—almost 200 a year. There are now about a thousand of those. So there are programs—I wouldn't call them set-asides; they are still competitive and reviewed and the best people get them, but the—it's recognized that one has to look at that group separately and we do that.

Mr. KOPETSKI. If I may continue on this, I've heard that—my professors tell me that one of the problems is that—we're going to face as a nation is that after World War II through the GI Bill and other programs, we got a lot of people into the teaching, the sciences, and that generation of folks are about ready to retire, beginning to retire.

Is this an area, a program area, though, with our new faculty, given this demographic function, that we need to enhance in a significant manner in order to kind of catch up with these more senior researchers?

Dr. MASSEY. Well, within the funding that we have, I think the balance is, if not the best we can do, it's certainly appropriate. It's

always difficult to know how you should achieve this balance of putting money focused on new faculty versus experienced researchers. You certainly don't want people in the midst of their careers who are doing excellent work to lose their funding, you know, but you don't want the new—you don't want to turn off young researchers, either.

Now, about a fifth of the—of all the research each year does go to first-time researchers. Now, whether that's the right number of not, but it's not an insignificant number.

In terms of the need for new faculty after the retirements come about, this is a concern of everyone in the field and then the question is how do you keep the input—on the input—recruiting people into the field until that bulge passes and how do you keep those there who are now doing research, but find it difficult to get faculty positions?

This is a very difficult problem and we're just restrained from really dealing with it adequately by the constraint on funds that we have. It's one of the burdens that the scientific community is feeling, as well as the university community.

Mr. KOPETSKI. Well, and that's part of our mission—is to come up with some solutions and I look forward to working with you and your staff on these very kinds of problems.

Thank you.

Thank you, Mr. Chair.

Dr. MASSEY. Thank you very much.

The CHAIRMAN. Thank you, Mr. Kopetski.

Mr. Rohrabacher.

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

Just to follow up on my colleague's line of questioning, I did find it fascinating that you underscored the importance of research at our universities in your statement and yet we're all aware of some of the criticisms that have come forward in the last few months, and especially some of the revelations of misuse of research money at universities, and I wonder if there are new types of controls that you plan to be instituted to make sure that research money is actually being well-used and not being spent on certain types of yachts and other things that we've heard about.

Dr. MASSEY. We are not—I don't see the need at NSF, from being here, to have any major changes in our systems. I think particular incidents have come to light in the last few weeks that point out the need to make sure the system, as we have it, works properly, but I don't think—at least to me—they point out the need for any overhaul, major overhaul in the system.

As I said in my opening statement, incidents that decrease the public's and Congress' confidence in our ability to manage the funds that we have effectively are certainly unfortunate. I think now what we have to do is make the case that in the overwhelming majority of instances that the funds are used efficiently, adequately and appropriately and I believe that to be true.

Mr. ROHRABACHER. So the—basically you're suggesting that the examples that got such a lot of publicity in terms of not just from the Science Foundation, but from others, scientific grants, were anecdotal in nature, but not reflective of a major problem that are across the country, in terms of misuse of scientific research funds?

Dr. MASSEY. I think they are reflective of a major—what I should first say is not—the NSF really has very little involvement in negotiating and monitoring and auditing indirect cost rates. As you know, the auditing agencies for all universities is either HHS or ONR, so our direct involvement in that is—is nonexistent. We have a few museums and other areas that we audit.

I think it's reflective of a major problem, not—but I don't think the major problem is deliberate misallocation or—of Federal funds, inappropriate spending. I think, one, the system has become very complex and should be looked at and it requires—puts a great burden on both universities and the Federal Government. I think in the instance that we are witnessing, and you're speaking of, I think both parties simply felt or testified to the fact that their—in order to monitor their expenditures, they didn't have adequate resources or didn't devote adequate resources.

So I think we should look at ways to simplify the system so that all parties can get maximum benefits from the funds without spending an undue amount of time and money in simply monitoring.

The other problem I think it points out is one we could spend a great deal of time on and that is the pressures that universities are under to maintain a research base at a time when resources are very short and the cost of research is—has become ever more expensive.

Mr. ROHRABACHER. Yes, but it would seem that some universities have been willing to use even these scarce funds and just sort of take them for granted to the point that they're using them for some very questionable—I'm not just talking about, of course, funds from Foundation, but other scientific funds as well, just taking them for granted and some very prestigious universities, at that.

You mentioned earlier the involvement of minority groups in the sciences and I remember the opening of a—especially in Tuskegee Institute, of an aerospace center, and I was wondering if your Foundation, the Science Foundation, was involved with this and what's going on there now?

Dr. MASSEY. I don't know if we were involved with that particular project. I don't think so. Were we? The Aerospace Center? I think that was—was that NASA?

Mr. ROHRABACHER. A lot of different agencies put funds into that—

Dr. MASSEY. I just don't know. We fund programs at Tuskegee and most of the all historically black colleges and universities, but I just—I know I've been to their—to that center you speak of and I just don't know if we had any role in that particular project.

Mr. ROHRABACHER. And as—and as your opening statement stated, as we enter into an age where technology is becoming evermore important to mobility, both as a nation and as individuals, some minorities and minorities in America, many of them seem to be left out and you had some, you know, some voice of optimism there, but you—are—you also were fairly pessimistic at the numbers. Are we going to see those numbers in the next five years—are we going to see some change in that? It's so important that we have people in our black community and people in their Hispanic

community be able to—be able to handle computers and handle some of the jobs that are going to be, you know, dependent on these skills in the future.

Dr. MASSEY. Well, I'm both optimistic and pessimistic. I'm optimistic—pessimistic because the numbers and the growth simply have not change dramatically since I've been actively involved in these activities. There's progress, but when you look at the percentage of blacks and Hispanics in science and engineering, those percentages just are not growing very rapidly.

I'm somewhat optimistic because when you look at the number of youngsters who enter college or who leave high school expressing an interest in these fields, those numbers have been growing somewhat, but even if they haven't, one at least can see a place where you can make a difference in the short term. And that is, if you could just keep in the field all of those, or a majority of those youngsters who go to college expressing an interest in science and engineering, and who leave the areas, the attrition. And here's an area where I don't think we've put enough emphasis and there's a new program in NSF, the Alliance for Minority Participation, which will focus on that critical problem.

You know, if one could simply cut in half the attrition of minorities in these fields now, we could make a dramatic difference in percentages because the numbers are small, but at least it would be a start and one needs to start somewhere, so I—and there are other areas in working with high schools where students express interest and we lose them in the system that one can see the possibility of making some progress.

Lately, I have come to the conclusion that we have to begin, as I've said on occasions, to perhaps think globally, but act on a local level, and not be intimidated or disappointed or pessimistic about the fact that these large numbers are not growing but begin to address the problem at a level where you can make a difference and measure the difference, and this is in line with what I said earlier, that I want to see more of our programs in areas where we can measure the output and be held accountable for the outputs of the programs and this seems the obvious one.

Mr. ROHRABACHER. One last thought and that is I think that more important than anything else to members of whatever community, whether it's the black community, Hispanic community or just whatever group of Americans you're talking about, especially when we're talking about how to influence young people, it's that you have role models and I'm afraid that perhaps in the black community, there aren't as many role models as there should be and—so I'd like to commend you personally for being a role model and hope that you use your influence in the black community to show young people in your community that this is a way to go because I think that far too often, even among middle-class and upper middle-class youngsters, we're just basically—who do we show as role models? We're showing investment bankers and lawyers and perhaps we need more role models to step forward and give publicity to more role models in the sciences and in math, both in the minority community and as middle-class and upper middle-class communities as well, so thank you and I hope you do use your influence that way and appreciate your testimony.

Dr. MASSEY. Thank you. It would certainly help my image in the community if I could have the budget passed at its full request.

[Laughter.]

The CHAIRMAN. Mr. Nagle.

Mr. NAGLE. I first want to welcome you and secondly, I want to congratulate you and thirdly, to assure you that I look forward to working with you as a member of the committee.

But I also—and this is not your fault because you were not present when the budget was formulated—but I don't see the kind of clarion call in this budget to address the crisis, I think, that we face in our math and science education. I recently saw studies where by the time the child reaches the seventh grade, 70 percent of them no longer have an interest in science or math. I saw studies where 30 percent of our high schools aren't even teaching physics.

In 70 percent of our high schools, some of our high schools don't teach chemistry. I saw the statistics on what happens if a person goes in to science as an undergraduate, the likelihood that student will ever get through to the Ph.D. category, and they're slim.

They're better if they go to a small school than they are if they go to one of the large research institutions, like Stanford or UCLA or the University of Iowa. I see results of the United States in competition with foreign countries and our students are finishing dead last. We're even in low places in terms of Third World countries who have better math and science education.

I just don't see in this budget a real commitment to recognize this crisis, that we're producing—every high school class of graduates—the odds are that that class is going to be scientifically illiterate when they come out of the process, and I just kind of wonder if I could ask you just a hypothetical question, that if you had more money—let's even give you an unlimited budget, since it's your first day here—what kind of funding and programs would you address? What kinds of initiatives would you commence to get at this crisis that we seem to have rapidly emerging in terms of our high school and our grade school education and our failure to bring kids through the undergraduate process up to the Ph.D. level to the illiteracy that seems to exist among many of our high school graduates?

What would you do more than what you've requested? This isn't your budget, so, I mean, if you had a wish list, what kind of things would you be placing greater emphasis on than what we see in the President's proposal?

Dr. MASSEY. Well, I share your views about the importance of putting more resources into this area and also the great need there, but I think this is a very—maybe it's not a clarion call, but it's a very loud shout. This is a very healthy increase for the National Science Foundation in the area of education and human resources and it's not just this year's increase. We've had a dramatic increase over the past three years.

It's the fastest-growing area of the budget. It's grown since 1987 almost 250 percent. That may still not be enough, but we have to, within the Foundation, make sure, from our perspective, that we adequately manage the resources that Congress gives us and that we are able to put them into the field to actually carry out the pro-

grams, and so, in all honesty, at some point, when you want to give me resources and I would say, I don't think we can adequately manage them unless you give us more people or more resources within the Foundation and the number of people we have has been limited over the past few years.

Mr. NAGLE. You can assume in my question that there'd be an adequate appropriation for more people and personnel to handle the program.

Dr. MASSEY. Well, I think we would—the emphasis of where we have them—we—pre-college education, in the long run, teacher enhancement, the priorities that have come out of the FCCSET process this year, you would try to get more teachers and reach more teachers and students through the programs.

Let's just take an example. We had the Statewide Systemic Initiative this year. We just received proposals. I don't know the exact numbers, but I think there are around 30 or so—30 and we're going to be able to fund about—about eight to 10, so these are very good programs. They are very good programs. There's a great deal of interest and if we could fund them all, I think it would go a great—be a great step forward in addressing the problems you alluded to. And there are other areas. We can't fund all of the requests that we have.

The programs we have in place, I think, are the right mix right now in terms of what NSF's goal is. Now, NSF is not the only player or not even the major player in terms of operating programs to improve education. Our primary goal, as I see it, is to fund programs that can provide models for the States and local areas to copy and to implement and also working with the Department of Education and other agencies to initiate and stimulate action by those that have to carry them out.

Mr. NAGLE. I represent a congressional district—this will surprise you—I'm from Iowa—no reason you'd know that—but I represent a congressional district that has one of the highest concentrations of undergraduate college students of any congressional district in the country. I won't go into the litany of all the four-year colleges and universities that reside in the district or border my district, but it's quite substantial.

I was at Wurtford College recently and I met with the Science Department at Wurtford College. It's a small school. I think its enrollment is about 1900, and I asked them what they felt that their greatest need was as a small private institution and they said the biggest limitation they're facing, along with instrumentation modernization, facility modernization was the mix of undergraduate research projects to graduate research projects, that they felt that to be able to teach, undergraduate research funding needed to be strengthened because it worked, and frankly, it's the Grinnels and the Luthers that are producing our Ph.D. candidates, not to my great embarrassment, the University of Iowa where I graduated from.

Do you concur in that observation and is there anything in this budget to give them hope about funding for undergraduate research?

Dr. MASSEY. Yes, I totally concur both your views. I think the—Iowa is also producing Ph.D.s, but those four-year colleges are quite

key and critical in this regard and we have programs address—that address them. There is an instrumentation program that we've had for a number of years, very popular, research for undergraduate research programs in which they participate, too, a great deal. And undergraduate education is the second-highest priority in the under—in the education area, after pre-college education.

So this is one that I think we have put into the program, activities which are going to please those colleges. The request this year is $132 million and that's up by 30 percent from $100 million over the budget request for last year.

Also, this instrumentation program that's new this year in fact, will address just the problem that you alluded to, the problem that many of those kinds of colleges don't find in getting instrumentation, especially at the expense of instrumentation, which they simply can't afford.

Mr. NAGLE. Yes, my problem with that one, and I think you've already—I think I suspect you've already talked about this is we're terminating another very good program in the modernization and we're stopping that and we're starting the new initiative and starting the new initiative with considerably less numbers and I, frankly, have a problem with that, but you know, you're telling me that the increased—proposed increase in the administration from 50 million undergraduate research to 132 million?

Dr. MASSEY. From 100 to 132.

Mr. NAGLE. From 100 to 132. Okay, well, that is good news. That is good news.

Lastly, on this subject of education, and I have just one other technical one—I'm told that we currently have a teacher force of 2.6 million. I'm told that up to two-thirds of those could retire in the next decade. I'm told that we have to produce by the year 2000 1.6 million teachers more and they aren't going into science and math education training.

Any new starts or new initiatives to address what is going to be an obvious shortage in the educational community, particularly in math and science teachers?

Dr. MASSEY. As I said in my opening comments, teacher preparation, teacher enhancement is the highest priority, even within the pre-college envelope as a whole, and within all of these initiatives, especially the Statewide initiative, the focus is on teacher preparation and enhancement of the abilities of current teachers.

But I just should say, you know, those are large numbers and just to repeat, the NSF won't be able to address those large numbers except through our ability to show what kinds of things can work and our ability to help disseminate those things throughout the systems and that's what we have to come to.

Mr. NAGLE. And I recognize that there are other areas that have the responsibility in this area, too. I only wish that NSF was part of the defense agency. We wouldn't be having these difficulties in giving you the money.

[Laughter.]

Dr. MASSEY. I don't know about that.

Mr. NAGLE. Now, a little technical question for you, as you know.

Two years ago, we received a report on the government initiatives with regard to superconductivity. And it turned out at that

time that the Japanese were spending about five times as much annually in dollars, real dollars, in terms of superconductivity, research, government-sponsored is what the United States was. Our figure in the 1987, 1988 was around the range of 25 million, mostly to hold conferences and set up a toll-free line.

And I asked the staff what the figures, your figures were in this budget for superconductivity and how that compares with the Japanese efforts on that regard. We don't have a line item broken out for it; it is part of a category, and so I'm kind of curious to know if you have a number or figure for me and, if so, how much. Now, that's a very technical question. If staff wants to answer, that's fine.

Dr. MASSEY. Well, I'm given a number here that says we spend—in this year's budget, a request of $31 million for superconductivity. I don't know that's broken down between high-temperature materials, which I presume is what you're looking at. Do you know? About 27 for high-temperature superconductivity?

We are not the major player, as you know, in the United States in funding this. I think the Department of Energy funds much more than NSF in high-temperature superconductors. I don't know how that compares with the Japanese as a whole. Interestingly enough, just this morning, I was given a report that we have prepared that I can send to you just on this question, a very comprehensive report on how we compare now and our support and funding of superconductivity with the Japanese. Just got it this morning and I haven't read it myself.

Mr. NAGLE. We'd appreciate it if I could receive a copy of it. Kind of have an interest in this area.

Good luck.

Dr. MASSEY. Thank you.

Mr. NAGLE. Thank you very much.

The CHAIRMAN. Thank you, Mr. Nagle.

Mr. Gilchrest.

Mr. GILCHREST. Thank you, Mr. Chairman.

Thank you for coming, Dr. Massey—

Dr. MASSEY. Thank you.

Mr. GILCHREST. I'm sure you will probably have a position in the Department of Education after this hearing.

[Laughter.]

Mr. GILCHREST. Many of my questions were answered, so I'll focus in on the $100 million for encouraging—and this is an educational question—the 25 percent increase in programs to encourage women, minorities and disabled students. I suppose—it—the—as a part of that, we're emphasizing teacher preparation and enhancement activities.

Now, is that to bring teachers up to speed on how to communicate to those—to that particular—to those groups to encourage them to learn, to instill them with a sense of curiosity toward math and science? Is there—is there a connection between the money, the minority groups and the enhancement activities for teacher preparation?

Dr. MASSEY. I don't think that's so much the focus. I think the focus is to have programs that bring into the process those who are

minorities themselves or those who will be teaching minority students.

Jane, do you want to say a little more about that, if I understood—she's in our Education Division.

Ms. STUTSMAN. The $100 million that I think you're referring to is for programs that are specifically addressing different points in a pipeline for minorities, women and the disabled.

For example, we have several—a program that's directed at minority undergraduate students, Research Careers for Minority Scholars. We have a Minority Research Initiation program for individuals who are beginning their research careers. We have a faculty awards program for women, so those are the kinds of programs that are included in that $100 million that you were discussing there.

They are in addition to the things that we do in our teacher preparation and enhancement and other programs.

Mr. GILCHREST. I see. There was a comment in here that I find fascinating because I was never—I taught history and things of that nature, but I was never very good at math, and maybe a technical question—I wonder if that's inherited, that that's an inherited trait, because my children aren't very good in math, but there was—there is an interesting statement in here about attempting to stimulate wholesale change in the way States approach math and science education.

Could you allude a little bit to that—how are they going to provide a wholesale change in—that sounds interesting to me.

Dr. MASSEY. That's the program, the Statewide Systemic Initiative program, and what that means is the following: It starts from the assumption, observation, that in many States there may not be adequate resources, but there are a great deal of resources spent in trying to improve the quality of math and science education, but many of the States have not put together a coordinated plan to maximize the use of the resources or to bring together all the important players who have to be involved, the universities, the public schools, the school systems, the governments themselves. And what this program does is say, in effect, this is shorthand to the States, the NSF will give you—provide funding and resources to help you put together this plan with specific outcomes and goals and if you put this plan together and make a commitment to it, then we will contribute to a plan and support it.

And, in fact, the commitment is such that the proposal actually comes from the governor of the State, so that's the principal investigator, and the notion behind it is that if you bring together the resources that are already present around a plan that the participants themselves have agreed upon, you can make a difference—wholesale may not be the word, but a broad-scale difference in the entire system, rather than, as we have done in the past, simply maybe giving a grant to a college in the area, another grant to a school in the area without requiring, you know, on the whole, that they have a definite plan to change the whole system.

Mr. GILCHREST. So this way they come together as an organized team.

Dr. MASSEY. Oh, yes, throughout. And as I said, we had 30 proposals this year and we're going to fund eight. Eight to 10, depending, so we'll—

Mr. GILCHREST. And those are eight to 10 different States—

Dr. MASSEY. —the next few years—

Mr. GILCHREST. —eight to 10 different States?

Dr. MASSEY. Yes, eight to 10.

Mr. GILCHREST. Is Maryland one of them?

Dr. MASSEY. I can't tell you that.

[Laughter.]

Dr. MASSEY. Because I don't know.

Mr. GILCHREST. That's okay. Sounds fascinating.

The other one is, I guess this coordination and collaboration among industry, universities and the government, as far as funding—the competitive angle of NSF—

Dr. MASSEY. Right.

Mr. GILCHREST. —for research and development.

Dr. MASSEY. Right.

Mr. GILCHREST. The collaboration among industries, universities and the public sector and foreign nations must be encouraged. This collaboration, I guess, among—is there a particular industry that's targeted in something—in this networking, a particular area?

Dr. MASSEY. You mean, companies—no, no, nothing like—

Mr. GILCHREST. A certain type of—

Dr. MASSEY. That could change the—one of the programs, a new one, is a program that is somewhat like the—has the same principle as the State program and it says to a university or State, a State in particular here, that the NSF will put resources into a collaborative effort that brings therefore an industry and university, a sort of center, if you like, but that the State has to specify the area in which that center will carry out its research and development and the State has to sponsor it and put in funds of its own.

So it's—again, it's an attempt to stimulate the involvement and active participation of the local areas, universities and industries in that area, so what happens is the State, university and various companies come together and form a proposal that is sent off to the NSF, and this is a somewhat different from what we have done in other areas whereby we might fund a university center and then they go out and seek the active participation of the State and the industry.

In these new efforts, that collaboration has to be demonstrated before the proposal comes in. So it's an experiment. We'll see.

Mr. GILCHREST. Sounds great.

Dr. MASSEY. We'll see how it works.

Mr. GILCHREST. Dr. Massey, thank you very much.

Dr. MASSEY. Thank you.

Mr. GILCHREST. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much, Mr. Gilchrest.

Dr. Massey, I think that is probably enough for you for one day. That's two hours solid, which is pretty good practice to get you off to a good start.

Dr. MASSEY. Thank you.

The CHAIRMAN. What we do have is a few additional questions that either the members or the staff have submitted in writing and

we would like to submit them to you and if you could, at your convenience, respond—

Dr. MASSEY. Of course.

The CHAIRMAN. —we would use that to fill out the record of today's hearings.

Dr. MASSEY. Thank you, Mr. Chairman.

The CHAIRMAN. And with that, I want to express again our thanks and appreciation to you and we look forward to working with you.

Dr. MASSEY. Thank you very much.

The CHAIRMAN. The hearing is adjourned.

[Whereupon, at 4:25 p.m., the subcommittee was adjourned, to reconvene subject to 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
(202) 225-6371

April 18, 1991

Dr. Walter E. Massey
Director
National Science Foundation
1800 G Street, N.W.
Washington, D.C. 20550

Dear Dr. Massey:

We were pleased to receive your excellent testimony on April 11 concerning your assessment of National Science Foundation (NSF) programs and your views on future directions for the Foundation. In order to complete the hearing record, we would appreciate receiving your responses to the following additional questions.

1.a. *The August 23, 1990 NSF report of the Merit Review Task Force recommends that in the near term NSF simplify and streamline various aspects of the grant proposal process. Do you intend to act on any of these near-term recommendations?*

b. *The report also makes recommendations for long-term changes, including standard six-year grants requiring shorter proposals, starter grants for new investigations, and strategic research grants requiring no external review. What are your current thoughts on implementing these, or other, long-term recommendations from the report? Also, what are long and short-term implications of these recommendations on NSF staff requirements?*

2. *The NSF has recently announced the award of a Magnetic Resonance Imaging (MRI) Science and ..hnology Center with the University of Illinois taking the lead on the project. Supporters of the Superconducting Super Collider (SSC) have begun to claim that this award is due to the first spin-offs to come from the SSC project. Is that an accurate characterization? In what sense has any research specifically done for the SSC (or innovations to come out of that research) led to the decision to establish the MRI Center?*

3. The recent astronomy report from the National Academy of Sciences on priorities for the next decade assigns first priority to maintenance and upgrading of existing astronomy facilities. The report indicates that poor maintenance has reduced the effectiveness of some national facilities operated by NSF.

   Do you believe NSF needs to review its policies regarding support for operation and maintenance of national facilities versus support for new construction and project support for scientists using national facilities? Are you satisfied that the balance of support among these categories is correct?

4. NSF has recently instituted a statewide initiative in science education which has the objective of involving the governors and chief education officers of states in developing educational improvement plans to bring about permanent improvement in the delivery of science and math instruction throughout a state.

   What is your view of the likely effectiveness of this approach to improve science education? To what degree is coordination occurring with the Department of Education and other agencies which have science education programs in ensuring maximum effectiveness of federal leverage in instituting statewide reform?

5. The Foundation administers the following set-aside programs: Presidential Young Investigator Awards, Experimental Program To Stimulate Competitive Research (EPSCOR), and Small Grants for Experimental Research. Please comment on the effectiveness of each program, and how it is evaluated.

I appreciate your attention to this request. Your reply will be included in the printed hearing record.

Sincerely,

George E. Brown Jr.

GEORGE E. BROWN, JR.
Chairman

GEB/Wns

QUESTIONS FROM REPRESENTATIVE GEORGE BROWN

QUESTION: The August 23, 1990 NSF report of the Merit Review Task Force recommends that in the near term NSF simplify and streamline various aspects of the grant proposal process. Do you intend to act on any of these near-term recommendations?

ANSWER: The Merit Review Task Force Report listed seven short-term recommendations. The Foundation has already responded to many of these:

1. Simplify Budgets for Individual Investigator Proposals;

   While this idea has been discussed with the community during the past six months, no changes are planned at this time.

2. Simplify Proposal Preparation and Review Procedures: Shorter Proposals;

   I have asked the Assistant Directors to review problems with the existing 15 page limit for proposals and to recommend if additional changes are needed.

3. Automate Processing of all Continuing Grant Increments;

   The process of automatically processing continuing grant increments, when appropriate, began this year.

4. Implement Use of Standard NSF Forms and Electronic Mail Review Templates;

   This recommendation is more appropriate as a long-term goal for the next 2-3 years. NSF divisions are increasing use of electronic mail and FAXes to receive reviews. One division is experimenting with using FAX for reviews by supporting an 800 telephone number.

5. Critically Assess Current Practices at all levels;

   I will ask the Assistant Directors to examine the disciplinary divisions this summer with the goal of eliminating redundancies, if they exist.

6. Introduce Annual Directorate Staffing Review;

   It is my plan to begin a review of the Foundation's staffing needs this summer.

7. Eliminate Requirement for Six-Month Extension Memo;

   This recommendation was implemented in 1990.

QUESTION: The report also makes recommendations for long-term changes, including standard six-year grants requiring shorter proposals, starter grants for new investigations, and strategic research grants requiring no external review. What are your current thoughts on implementing these, or other, long-term recommendations from the report? Also, what are long and short-term implications of these recommendations on NSF staff requirements?

ANSWER: The Merit Review Task Force (MRTF) Report encourages a research system driven by long term rather than short term problems. The Report suggests that changes are needed in the system of awarding individual investigator grants in order to address the long term goals advocated by the Packard-Bromley Report with respect to grant size and duration. I do not agree that a change in the current system is necessarily needed to accomplish these goals. Instead, specific objectives can be established in each directorate, and senior management can address these goals explicitly over a several year period.

The option to renew a proposal for three years, at the discretion of a program officer, for a total of six years, is very similar to the Foundation's existing Creativity Extension which permits a program officer to extend a grant by two years without review. However, lengthening grant durations may be addressed more simply, in my view, by making a small number of awards with duration of four to five years. Thus, I will not be encouraging six year grants without review.

NSF currently supports about 1,400 new researchers each year through the Presidential Young Investigator (PYI) program and discipline-specific research initiation programs, as well as through the regular disciplinary research programs. A Task Group has been appointed to examine this NSF investment in young researchers with the purpose of determining if a new NSF-wide starter grant program is needed.

The suggestion for "strategic research grants" is based on the Foundation's experience with a relatively new program, Small Grants for Exploratory Research (SGER). The MRTF suggestion really does not differ in substance, but only in name, from the SGER program. In essence, the MRTF confirms that this program should encourage sensible risktaking and respond to requests for important feasibility studies.

With respect to staffing, the MRTF Report makes clear that staffing pressures have grown substantially over the past decade. Not only are the staff handling more proposals, but the proposals are often more complex and frequently interdisciplinary in subject, spanning more than a single division or directorate. Further, NSF has greatly expanded its responsibilities in the area of education and human resources. Thus, there is now a need for additional staff in almost all areas of NSF.

It is my intention to insure NSF continues to operate a lean and cost-effective operation, but that the staff and related support are adequate and appropriate to insure a focus on long-term quality and excellence. The MRTF report recommendations offer the potential of improving future operations and reducing unnecessary paper work, which will have the benefit of assuring high quality.

QUESTION: The NSF has recently announced the award of a Magnetic Resonance Imaging (MRI) Science and Technology Center with the University of Illinois taking the lead on the project. Supporters of the Superconducting Super Collider (SSC) have begun to claim that this award is due to the first spin-offs to come from the SSC project. Is that an accurate characterization? In what sense has any research specifically done for the SSC (or innovation to come out of that research) led to the decision to establish the MRI Center?

ANSWER: The research at the Texas Accelerator Center in magnet design for the Superconducting Super Collider (SSC) provided the background leading to the design of the 4T magnet proposed to be built and used in the Magnetic Resonance Imaging (MRI) Science and Technology Center at the University of Illinois. The 4T magnet, incorporating some valuable shielding features developed for the SSC magnets, offers unique advantages for MRI. To claim the MRI center as the first spin-off of the Texas Accelerator Center's work is an exaggeration and not an accurate characterization. It is no more than all science being considered a spin-off of previous scientific advances within a field.

This new magnet, while a major component of the center, is still only one aspect of the center. The decision to establish the center arose not only from the possibilities inherent in the 4 Tesla(T) magnet's advanced design. It also provided the opportunity to develop other current technologies and expand their use in the exploration of physiological processes, structure, and phenomena and increase the resolution heretofore not realized. This includes such techniques as microscopic NMR imaging, stochastic NMR imaging and image processing and visualization techniques.

QUESTION: The recent astronomy report from the National Academy of Sciences on priorities for the next decade assigns first priority to maintenance and upgrading of existing astronomy facilities. The report indicates that poor maintenance has reduced the effectiveness of some national facilities operated by NSF.

Do you believe NSF needs to review its policies regarding support for operation and maintenance of national facilities versus support for new construction and project support for scientists using national facilities? Are you satisfied that the balance of support among these categories is correct?

ANSWER: The question of balance between support for existing national facilities, support for new construction, and project support for scientists is a constant concern of the Foundation at all levels. Infrastructure issues have surfaced as a priority item, and much attention is being given to reviewing and addressing these concerns.

Within available resources, the balance between new facilities and existing infrastructure has been maintained as fairly as possible to maximize the scientific productivity of the astronomical community. The existing astronomy facilities continue to operate reliably with dedicated and talented staff members, and excellent science is being done by a wide base of community members.

The Advisory Committee for Astronomical Sciences, which includes representatives of the astronomical community, meets twice a year to address issues of planning and priorities, and is extremely concerned with these questions of infrastructure and balance. In addition, once every three years a Committee of Visitors is convened to do an in-depth review of the activities (proposal pressures, facilities, instrumentation, etc.) and report to the main advisory committee.

The 1990 Committee of Visitors for the astronomical sciences noted in particular that infrastructure needs had outstripped budget growth over the last several years. These stresses on the infrastructure manifest themselves differently in various parts of the division and must be addressed in quite diverse ways.

For example, at the National Optical Astronomy Observatories (NOAO), user services have eroded, and telescopes and software systems are in need of upgrades. We have begun to address these infrastructure problems in the FY 1991 budget. Needed improvements to the physical plant are scheduled for both FY 1991 and FY 1992, and additional upgrades of NOAO facilities and services will be addressed in coming years.

A different problem has appeared at the National Radio Astronomy Observatory (NRAO), where the construction of the Very Long Baseline Array (VLBA) has been a strain on NRAO. The VLBA construction schedule was stretched out due to shortfalls in the funding appropriated by Congress, causing the construction cost to increase and reductions to be made to the budget for NRAO operations.

During this period, maintenance problems developed with the Very Large Array (VLA) (rails, power cables, waveguides) that could not be fully addressed. Also, computing support and instrumentation upgrades lagged at NRAO. In FY 1991, NRAO will receive funding to begin addressing infrastructure issues. In FY 1992 the amount devoted to repairing the base programs will increase slightly. Once VLBA construction is finished, additional funding will be proposed to address infrastructure needs at NRAO.

Given the concern over maintenance of existing facilities and infrastructure, you may wonder why the Foundation plans to build the new 8-meter optical/infrared telescopes. These telescopes are the highest priority for land-based astronomy in the recently issued Bahcall report on priorities in astronomy for the next decade. They will be the first large optical instruments built for the astronomy community since the mid 1970s. The 8-meter telescopes are essential for the vitality of U.S. science. Without these forefront instruments, optical and infrared astronomy in the U.S. would become second rate.

At the National Astronomy and Ionosphere Center (NAIC), whose main facility is the telescope at Arecibo, Puerto Rico, staff and user services have diminished, and some needed equipment is outmoded. The current Arecibo Upgrade, which is jointly funded by NSF and NASA, will provide modern facilities and equipment for NAIC. When the upgrade is completed in FY 1993, additional funds will be provided for operations.

QUESTION: NSF has recently instituted a statewide initiative in science education which has the objective of involving the governors and chief education officers of states in developing educational improvement plans to bring about permanent improvement in the delivery of science and math instruction throughout a state.

What is your view of the likely effectiveness of this approach to improve science education? To what degree is coordination occurring with the Department of Education and other agencies which have science education programs in ensuring maximum effectiveness of federal leverage in instituting statewide reform?

ANSWER: The Foundation is confident that this approach will be effective in improving science education. While single purpose programs are meeting needs in particular areas such as the preparation of teachers or the development of curriculum, the systemic approach strengthens efforts to improve science education by addressing all of the components of the system in a coordinated and integrated way.

The systemic initiative will support coordinated efforts in curriculum development, in teacher education and inservice training, in the creation of student assessment processes, in the improvement of materials and laboratory resources, in the development of administrative and public understanding and support, and in the establishment of accountability measures. The Foundation believes that coordinated, systemic efforts provide the most effective way to implement change in the nation's schools. Some positive results are expected to occur even in those states that do not receive NSF funding, as many states have begun thinking about and planning for the implementation of systemic reform as a result of the Foundation's leadership in this area.

- The productivity of EPSCoR faculty researchers has also experienced marked improvement. For example, in Alabama the total number of publications per faculty increased from 3.1 to 6.5, respectively during the EPSCoR grant period. In Kentucky, meanwhile, the number of proposals submitted by faculty to external funding agencies tripled.

Evaluation of the EPSCoR initiative is an ongoing process that incorporates merit review procedures. The program is currently being evaluated in two different ways:

- In FY 1991 the seventeen current participants will participate in a recompetition for three years of EPSCoR continuation support. The review consists of merit examination of the achievements to date and potential for future development.

- An electronic data base has been established for the seventeen states that is providing long-term tracking of (1) state contributions, (2) faculty performance, (3) education and human resource development activities, and (4) institutional and individual achievements for all participating researchers.

Small Grants for Exploratory Research (SGER)

Basic data about the first year of SGER activities (FY 1990) has been gathered and analyzed. The second evaluation stage, i.e., assessing the outcomes of the FY 1990 grants and seeing how they relate to later proposals submitted for regular review, will be underway shortly and is expected to take several months.

In FY 1990 NSF received 531 SGER proposals and awarded 244 -- a higher award rate than in most NSF programs, but applicants are strongly encouraged to get a positive signal from a program officer before submitting an SGER proposal. Half of the proposals were from, and two-fifths of the awards to, Principal Investigators that had not received a prior grant from NSF. A total of $8.3 million was awarded, and the average grant size was $34,295. Strictly speaking, SGER is not a set-aside program but an alternative granting mechanism for all program officers to use within their program budgets. In FY 1990 SGER proved to be a very convenient way for several programs to quickly make grants for work on phenomena associated with the two natural disasters of that year, Hurricane Hugo and the Loma Prieta Earthquake.

Coordination is occurring with the Department of Education and other agencies which have science education programs. The Statewide Systemic Initiatives (SSI) program solicitation states that there must be an integration of activities carried out with other federal funds such as those from the Department of Education's Eisenhower Mathematics and Science Education Program. During the development of the SSI program, discussions were held with various other agencies as well. Also, NSF staff met with the state coordinators of the Eisenhower program as well as with the education coordinators of the Department of Energy's national laboratories. The degree to which states are integrating the various activities supported by other federal agencies is a factor in the evaluation of the proposals under consideration.

QUESTION: The Foundation administers the following set-aside programs: Presidential Young Investigator Awards, Experimental Program To Stimulate Competitive Research (EPSCoR), and Small Grants for Experimental Research. Please comment on the effectiveness of each program, and how it is evaluated.

ANSWER: Presidential Young Investigators Program

The PYI program was the subject of an assessment published in December 1990 by NSF's Program Evaluation Staff. A copy of their report is attached.

The goal of the PYI Program is to help ensure a continuing supply of practicing scientists by providing financial support to promising young researchers. Among the findings of the 1990 evaluation was that PYI's have achieved full professor at a rate that exceeded that of all other comparison groups. Also, program statistics for matching funds indicate that from the beginning of the program external matching funds support has amounted to about 80% of the maximum allowed, which to date totals in excess of $110 million in donations from the private sector. These statistics provide an assurance that the program is effective in meeting its goals.

Informal evaluation has been accomplished in many ways and has lead to various program changes over the years. For example, former NSF Director Bloch met from time to time with groups of PYIs to discuss their experiences. Advisory and visiting committees also provide their comments to the Foundation. In addition, now that the program has been in existence for several years, NSF management is actively considering whether to make fundamental changes, or to continue it in about its current form.

Experimental Program to Stimulate Competitive Research (EPSCoR)

The effectiveness of the EPSCoR initiative is evidenced in three ways: (1) improvements in research infrastructure; (2) individual research achievements; and (3) increased research competitiveness. Examples of each are shown below.

Infrastructure Improvements

- Several States have provided research appropriations in support of EPSCoR activities. For example, for the first time Idaho has appropriated $2.0 million solely for academic research.

- EPSCoR has assisted in the development of State science and technology authorities/commissions that provide ongoing support of R&D within the State. For example, the Oklahoma Center for the Advancement of Science and Technology has provided over $40 million for S&T since 1987 and in Mississippi members of the State EPSCoR committee have been named to the Governor's S&T advisory panel.

Individual Research Achievements

- EPSCoR researchers have received numerous awards and honors. For example, Judy Van Houton (VT) received a seven-year NIH award of excellence; Jack Horner's (MT) paleontological breakthroughs earned him a MacArthur Fellowship; and Ken Showalter (WV) has received national recognition by the national chemical research community for his pioneering research in chemical dynamics.

- In 1989 Montana and Mississippi State Universities each were awarded NSF Engineering Research Center Grants, (two of the three 1989 awards went to researchers at EPSCoR institutions); EPSCoR researcher M.K. Wu (AL), in collaboration with Paul Chu (TX), made significant discoveries in high temperature superconductivity that brought him international recognition; and S. McKeever's (OK) EPSCoR supported research in optical technology was so successful that it subsequently received $3.5 million of external research support.

Increased Research Competitiveness

- The level of external research support generated by EPSCoR researchers has grown dramatically. For example, in four years 35 Oklahoma EPSCoR faculty generated $3.5 million primarily from Federal sources, through the normal competitive research grant process; in Louisiana 82 faculty generated over $10 million; and Arkansas increased its NSF funding from $116,000 in 1980 to $1.2 million in 1989. Institutions have shown comparable improvements (e.g., through EPSCoR the University of South Carolina improved its rank, in acquisition of external funds, from 46th to 28th).

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