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FEDERAL RESEARCH AND DEVELOPMENT BUDGET AND THE NATIONAL SCIENCE FOUNDATION

HEARING

BEFORE THE

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE

ONE HUNDRED SEVENTH CONGRESS

SECOND SESSION

MAY 22, 2002

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ONE HUNDRED SEVENTH CONGRESS

SECOND SESSION

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FEDERAL RESEARCH AND DEVELOPMENT BUDGET AND THE NATIONAL SCIENCE FOUNDATION

WEDNESDAY, MAY 22, 2002

U.S. SENATE,
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Subcommittee met, pursuant to notice, at 2:39 p.m. in room SR–253, Russell Senate Office Building, Hon. Ron Wyden, Chairman of the Subcommittee, presiding.

Senator WYDEN. The Subcommittee on Science, Technology, and Space will come to order. I'm very pleased that we're joined by our colleague and good friend from Georgia, Senator Cleland. He's under a very tight time schedule, so I will let him begin with his opening statement.

Senator CLELAND. Thank you very much, Mr. Chairman. I really have three questions of Dr. Colwell. If I could go ahead and ask them, then I'll be free to go.

Senator WYDEN. Well, why don't we go ahead and do that? We are nothing, if not flexible on this Committee.

[Laughter.]

Senator CLELAND. Thank you.

Dr. Colwell, thank you very much for being with us. I think that many of us would agree that in order to advance information technology equitably in today's society, it's necessary to ensure that we strive to close the digital divide that exists between the more affluent educational institutions of higher education and those with less means to compete for R&D funding.

Toward this end, last week the Senate Commerce Committee reported out S.414, legislation which I sponsored and which is cosponsored by 15 of my Senate colleagues, nine of which are on this Committee, actually. This legislation would create a $250 million grant program in the Department of Commerce to help close the technology gap at Minority-Serving Institutions of higher education in America. The funds would go directly to the institutions—Historically Black Colleges and Universities, Hispanic-Serving Institutions, and Tribal Colleges and Universities. Funds provided under this legislation could be used for such activities as campus wiring, equipment upgrade, technology training, and hardware and software acquisition. MSIs can compete for funding regardless of where they are on the technology spectrum.

Prior to the Committee markup, there were discussions by Senate staff and the associations representing Minority-Serving Institutions, or MSIs, on whether to leave the technology program in the Department of Commerce or move it to the National Science Foundation. At the end of the day, the decision was to leave it in Commerce, even if the authorization level of the program had to be significantly reduced.

Some of the groups said they came to this decision out of concern that NSF programs serving Minority-Serving Institutions historically have suffered from administrative neglect and inadequate funding.

Dr. Colwell, I have been told that, according to data from the NSF budget division, no Historically Black College or University or Tribal College was listed among the top 100 institutions of higher education receiving NSF awards last year, and less than one percent of this NSF award money went to Hispanic-Serving Institutions. Can you tell me if this information, as far as you know, is accurate? And, if so, why do you believe this is the case?

Dr. COLWELL. In order to respond forthrightly and directly to your question, I would have to say that I would have to go the budget for the exact percentages and figures. But I would like to bring to your attention the strategy that we are using to address this very important and critical issue of the digital divide in minority-served institutions, and that is not simply to fund only direct grants to the institutions, but to include, across the foundation, horizontally integrated programs to address minority institutions and minority participation in science and engineering.

We believe it far more effective to include every directorate and to put the responsibility on all of us, as an agency, to work toward improving the participation of minorities in science and engineering education so that the programs that we do have, such as the Louis Stokes Alliance for Minority Participation, an extremely successful program, we intend to increase in the coming years.

This program is doing very well, and it is essentially level-funded this year, but it is our intent to increase that program, because it has graduated 21,000 science and engineering bachelors degrees in the last decade or so, and it has had approximately 171,000 participants in the program. We have some extraordinarily good programs which we think are highly effective.

We are addressing this issue with a great deal of attention, because I do consider it to be the most important issue for the next decade of this country.

Senator CLELAND. Well, it's my understanding along those lines that, in 1999, the National Science Foundation awarded the nonprofit organization, Educause, a four-year $6 million grant for the purpose of upgrading technology at minority-serving colleges and universities. I've been told that the grant money flowed to Educause and not the institutions themselves, that Educause, not NSF, made the decision on which MSIs were to be involved in the technology project, and that Educause provided the technical assistance to the institutions. Is that correct?

Dr. COLWELL. The funding was made to Educause, sir, and the program is being coordinated by Educause. Educause is an effective organization, but if there are some difficulties with the awarding

of the funds, we will certainly look into it. The process that they are using is a very appropriate one.

Senator CLELAND. Could you please tell us what activities were funded with the Educause grant? Have you got any idea?

Dr. COLWELL. I can ask the education representative who is here. Would you speak to this? Would you identify yourself, please?

Mr. FORTENBERRY. I'm Norman Fortenberry, division director of undergraduate education. We could provide the information in detail for the record. [The information referred to follows.]

Activities Funded Through the Educause Grant

The award to Educause provides support for a series of activities designed to enable minority-serving institutions to prepare for and then participate in national advanced networking initiatives, including lnternet2 and Next Generation Internet (NGI). Included are workshops and training programs intended to assist administrators in devising technology strategies and financing plans for their institutions. Similar programs will develop the human support infrastructure in these colleges and universities. Yet other activities are aimed at preparing the faculty and students in the use of the high performance networks. An important aspect of this latter array of activities is the involvement of the Education, Outreach, and Training (EOT) program that is part of NSF's Partnerships for Advanced Computational Infrastructure (PACI). Coupled with and integral to all of these programs and activities will be experiments with and prototypes of advanced, innovative network technologies for Internet access or for vBNS or Abilene access. In particular, these advanced technologies will seek to attack the problems of cost and access for locations that have limited telecommunications options.

In general, what Educause is doing is working with a variety of colleges. They have teams that go out to the colleges, work with the college representatives to identify their needs, and then provide the assistance.

We'll provide the details for the record.

Senator CLELAND. All right, thank you. I didn't want to get too specific, but I had to get a little feedback here. Have you done an evaluation of this Educause grant?

Dr. COLWELL. The grant is in its second year. We would not be doing evaluation until completion.

Senator CLELAND. Does the National Science Foundation commonly award grants to nonprofit organizations like Educause rather than directly to the colleges and universities themselves?

Dr. COLWELL. This is a consortium of educational institutions. We routinely make awards directly to institutions on a competitive basis, and this award was made competitively. It is not an exception to the rule. It is simply one of the mechanisms that we use, but not as frequent as a direct award.

Senator CLELAND. Well, the funding mechanism is one of the things that gave rise to my pushing and sponsoring S.414. There are two provisions in my legislation which serve to guarantee the grant money is targeted to those who, number one, need it most. The grants are required to go directly to the eligible Minority-Serving Institution. And, two, the peer-review panels established in S.414 are required to be made up of members of the MSI community.

First, let me just ask you if you think the National Science Foundation would want to administer the program created by this legislation, should my legislation be enacted?

Dr. COLWELL. Sir, we are poised to do an outstanding job. We will work extremely hard to achieve what is the most important objective, as was stated in the report addressing homeland security, the Rudd–Hartman Report. Second only to an attack on one of our major cities, which has already occurred, to lose leadership in science and math in engineering research and education, would be a catastrophe for our country.

The answer is, sir, if the money were put in the NSF budget, we would use it to serve the country well, and we would be diligent in applying the funds effectively.

Senator CLELAND. Thank you. Secondly, if S.414 is passed into law, if it's the will of a majority of the members of Congress to place the program at NSF, would NSF adhere to the intent of the legislation?

Dr. COLWELL. We would adhere to the intent of the legislation, sir.

Senator CLELAND. Yes. I presume so. Would you ensure——

Dr. COLWELL. Our record would show that.

Senator CLELAND. Yes. Would you ensure that the grants would go directly to the institutions themselves and that the peer-review panels would be made up of members of the MSI community?

Dr. COLWELL. The answer is yes, but I would also point out that we already do have members of Minority-Serving Institutions serving on panels, and so this would be entirely within the typical process of the National Science Foundation.

Senator CLELAND. Would the entire peer-review panel be made up of members of the MSI community?

Dr. COLWELL. I would suggest that it would be best to have a cross-section of the community, that it is very important, to do peer review in the NSF process, and it's critical that we have the very best representation, and this would include the Minority-Serving Institutions, on the panel, sir.

Senator CLELAND. Thank you very much for allowing me to ask these questions directly to you. I'm very much interested in overcoming the digital divide, and we appreciate your help in that regard.

I might say, Mr. Chairman, before I close, that when I graduated from high school, I wanted to be a science teacher, and I went to college. I was going to major in physics. That lasted three days, and there ended my career as a science teacher.

Senator CLELAND. But we appreciate those of you involved in science. Thank you very much.

Dr. COLWELL. Thank you, sir.

Senator WYDEN. I thank my colleague. You've been a leader in the effort to close the digital divide, Senator Cleland, and we very much appreciate all the work you're pursuing.

STATEMENT OF HON. RON WYDEN, U.S. SENATOR FROM OREGON

Senator WYDEN. Today, the Subcommittee on Science, Technology, and Space convenes to examine the federal research and development portfolio, with particular emphasis on the National Science Foundation. It's my belief that supporting sound science and encouraging technological innovation is simply the right role

for government. From calling the nation's technology experts and entrepreneurs to service after September 11th, to steering NASA back towards its original scientific mission, this Subcommittee, on a bipartisan basis, has spent the last year working to foster American research and development. The fields of mathematics research, social and behavioral sciences, and others have all been identified as ripe for major scientific advances. In the coming years, nanotechnology research funded by the National Science Foundation could aid the development of electronic circuits and devices from a single atom or a molecule.

Here is my bottom line. Failing to invest in programs that improve math and science achievement plays Russian roulette with Oregon and our national security that cannot be allowed to happen. As chair of this Subcommittee, with jurisdiction over the National Science Foundation, I'm unwilling to see America's science research and development sit stagnant when such great strides might be made.

In 1997, Congress committed to doubling the funding for research at the National Institutes of Health. I'm proud to report that the current White House, my congressional colleagues, and I are committed to maintaining that level of funding. But this nation's investment at the National Institutes of Health ought to be followed with a similar investment at the National Science Foundation.

The National Coalition for Science Funding has advocated a $718 million or a 15 percent increase in NSF funding over fiscal-year 2002 levels. Across five years, this will double the science research budget at the National Science Foundation.

I strongly support this proposal. It's my view that to realize the full benefits of investing in any one scientific sector, the whole spectrum of science must have adequate support. Advancements in one area may lead to amazing discoveries in yet another field.

For example, nuclear magnetic resonance was discovered in 1946. Over the next decades, NSF supported investments in science and instrumentation to help understand and harness this phenomena. The eventual result was magnetic resonance imaging, MRIs. Today, doctors worldwide use those MRIs to diagnose a variety of conditions.

The MRI illustrates a point that a number of our witnesses are going to address today. In the 1950s, it was hard to predict that funding an interesting physics experiment would eventually enhance human health. Nonetheless, this basic research in the physical sciences, practically applied, now saves lives around the world.

In another example, the advances in the human genome project would not be possible without recent leaps in computer technology that let the genome be sequenced. To me, this is the case for increasing National Science Foundation investment to match the efforts at NIH.

In this year's federal budget, the Office of Management and Budget applauded financial management at NSF with what's called a "green light" designation, but that applause was not accompanied by any actual increases in the NSF research budget. On the contrary, the budget increases funding for NSF research about 3.5 percent. When you consider the programs transferred from other agen-

cies account for about half that amount, the real increase is nearly negligible.

This is serious business, because highly promising scientific research is not taking place, just because the NSF can't fund it. Thirteen percent of highly rated proposals to NSF get rejected just for the lack of dollars. If Congress and the Administration could double the NSF funding, as funding was doubled at NIH, our scientific horizons would be broadened immeasurably. Not just the quantity, but the quality of the research could be improved, as well.

In the year 2000, the average NIH grant was nearly more than three times the size of the average NSF grant, and the NIH grant periods were more than a year longer. Scientists who depend on NSF need to be able to spend less time chasing funding and more time in their laboratories. Rarely does any financial investment hold as much promise for practical return as investment in scientific R&D.

I hope that today this Subcommittee can begin a significant and serious discussion of doubling the NSF research budget, realizing the potential for long-term, even life-saving dividends.

On a final note with respect to NSF, there is one program that I do not believe should be under the Foundation's jurisdiction. We've strongly opposed the proposed transfer of the Sea Grant College Program from NOAA to NSF. Last week, this panel ordered a bill reported which authorizes the Sea Grant Program within NOAA.

Today is going to give us an opportunity to hear from witnesses who will help us look at NSF and to the possibilities for the rest of the nation's scientific research and development portfolio. Dr. John Marburger, the President's distinguished science advisor, has discussed with me ways to discuss the skills and entrepreneurial talents of this nation's scientists and technologists to enhance homeland security.

In particular, Dr. Marburger, I want to express my appreciation to you and to the Administration for the help you have given us in developing the NetGuard proposal. As you know, at a time when we're mobilizing all across this country, the first responders and so many others, what we ought to be doing, as John Kennedy asked decades ago, is taking steps to mobilize other Americans, particularly those who are familiar with digital technologies. And with your help and the Administration's, we've been able to get that legislation out of the committee.

It's my view, as I said earlier, I think these are national security matters. I think you're playing Russian roulette with national security if you fail to invest in math and science programs that could beef up achievement levels and fail to make these investments that we're discussing today.

So I'm very pleased to have had a chance to work with you and, this afternoon, to talk about the nation's overall science portfolio as well as the interagency research programs, particularly in nanotechnology that we have discussed in the past.

I also want to give a brief introduction for our other witnesses. Dr. Rita Colwell, the director of the National Science Foundation, a very distinguished leader in the field. We're also pleased to have Speaker Gingrich here, who I had a chance to work with on health

and science policy when I was in the House. John Podesta, a senior advisor in the previous Administration, with a long, long record of interest and expertise in science policy.

And I'm especially pleased that Speaker Gingrich and John Podesta could be on the same panel. Some might think we're heading for crossfire or something this afternoon.

[Laughter.]

Senator WYDEN. But to have these two very distinguished leaders, leaders in politics who are perhaps best known as leaders in politics, to have a chance to talk about science issues, because they have spent so many years working in the trenches with science policy, is something I especially appreciate both of them making time for.

We're also going to have Dr. Alan Leshner here, of the American Association for the Advancement of Science, Mr. Thomas McCoy, of Montana State University, Dr. Marsha Torr, of Virginia Commonwealth University.

Before we go to our witnesses, I want to recognize my colleague Senator Allen. He and I, working together, were able to team up on several bills that got out of the full committee last week, particularly the important legislation to fund the cyber-security measures in addition to the NetGuard Bill. And it's been a real pleasure working with you, Senator Allen, and you can make any statement you proceed with.

STATEMENT OF HON. GEORGE ALLEN, U.S. SENATOR FROM VIRGINIA

Senator ALLEN. Thank you, Mr. Chairman, and thank you for your leadership on so many issues. I very much enjoy working with you. It's nice to find a kindred soul on so many of these important issues for the future of our country. I thank you for calling this hearing on the federal R&D budget and the National Science Foundation. I also want to thank one witness from the Commonwealth of Virginia, Dr. Torr, for being here. And it's good to see the president of VCU, Virginia Commonwealth University, here, as well, Gene Charney, sitting next to the Speaker and the rest of our distinguished panel.

Let me make a few opening remarks here, and then I want to listen to our esteemed panelists and let you all know where I'm coming from, and it's very close to your views, Mr. Chairman.

If one looks back on the last decade, in the 1990s, in our country we achieved what many thought was impossible, if they were even thinking about it. The economy grew, jobs were being created, standards of living were improved without driving up inflation. Much of the success in this country is due to the advancements and improvements from technology in the technology sector, which is a diverse sector—everything from the fabrication of semiconductor chips to the applications to the communications to the medical adaptations, education and the rest. The result, in the 1990s, was almost, in my view, an unprecedented expansion of opportunity and prosperity, the best clearly in the whole past century.

Now, this was done through innovation, innovation that improved our quality of life. It is a challenge now, as we're into this century, the next decade, and the tech sector is a little down right

now. But nevertheless, our challenge is to continue this innovation economy. And one of the key elements to this innovation process is a technically talented and competent and capable workforce. The National Science Foundation plays a key role in these opportunities in its education and research programs.

Now, I don't think the government ought to do everything. The government—the federal government has certain responsibilities, the state government has certain priorities and responsibilities. At the state level, your top responsibilities are law enforcement and education. At the federal level, it's national defense, national security, and education. Much of that education at the federal level, sure, is funding to the states for schools with maximum flexibility, but as far as the universities and colleges, it's through research grants, working with them in the private sector.

The federal government, as any government, needs to make sure that you have the right conditions precedent for opportunity and risk-taking and investment and jobs to occur, and that means we have to have pro-entrepreneurial tax policies, regulatory policies that are based on sound science, as opposed to political science.

But this is where you all come in, as part of the education aspect of it, the competitiveness of individuals. In this country, in America, an individual ought to be limited only by his or her imagination. I always loved de Toqueville's quote and observations back in the early part of the 1800s in this country about, "America is always on the move. Everything's in constant change, and the only things that have not been done are those that have not been attempted." But that concept, that drive, that spirit that we're only limited by our imagination will propel us forward.

Now, there's so much agreement here that I had several paragraphs of my opening statement here that Senator Wyden used, so I'm not going to get into those and repeat them. So this shows great agreement on where NSF and research and MRIs and all that works.

Now, one of the other important challenges that he did not talk about in such great detail is our scientific and economic leadership that is being reduced because there is a fewer number of American students pursuing mathematics, science, computer, and engineering degrees. The bill that Senator Cleland introduced, which I cosponsored, while I would have liked to see it expanded to schools in Appalachia and some areas like that, does not have the perfect harm, what can be helpful as far as Hispanic serving and historically black universities and making sure that students in those colleges and universities have the technology so that they can join in the great opportunities for jobs in the computer sciences area.

Now, a report in September of 2000 by the National Commission on Mathematics and Science Teaching for the 21st Century, entitled "Before It's Too Late," states that jobs in the computer industries and health sciences requiring science and mathematics skills will increase by 5.6 million by the year 2008—5.6 million, and that's just six years from now. According to this report, 60 percent of all the new jobs in the early part of this century will require skills that are held by just 20 percent of the current workforce.

I think it's absolutely essential that we do everything we can to make sure that Americans—I don't care where they may be in our

states or communities—that they're getting the education so they can seize those opportunities and get those jobs. I don't mind having folks coming in from elsewhere in the world. They're productive, useful to our system, and we welcome them, but there are a lot of people in this country that ought to be getting that education so that they can get those jobs. And we've heard from many federal agencies, not just NSF, but NASA, especially in aviation and aeronautics, that we have an aging workforce.

And I look forward to this—to hearing from the research community and leaders who are also very converse and knowledgeable about these challenges and how, in particular, we're going to address these concerns. They're concerns for the individuals—the individual's ability to compete and succeed in the future. But as they're able to compete and succeed, so does our civilization and our nation.

And I thank you all. And again, Mr. Chairman, thank you for holding this very important and timely hearing.

Senator WYDEN. I thank my colleague for an excellent statement, and we will be working on all of these issues together, as we have in the past.

Dr. Marburger?

STATEMENT OF HON. JOHN MARBURGER, PH.D., DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Dr. MARBURGER. Thank you, Mr. Chairman, Members of the Subcommittee. I have a longer written testimony that I'm submitting for the record and an abbreviated oral one, if you'll permit me.

I am pleased to appear before you today to discuss the President's Fiscal Year (FY) 2003 budget request for research and development. Shortly after I was confirmed as director of OSTP at the end of October by this parent committee, the director of the Office of Management and Budget invited me to attend and participate in internal OMB decision-making sessions involving science programs. I was glad to sit in on the budget reviews for science. They gave me a greater appreciation for the issues and an opportunity to represent the science perspective on important aspects of this budget, such as increased accountability and performance measures for basic science agencies.

The terrorist attacks on September 11th dramatically changed the context for this budget. The attacks laid bare vulnerabilities in our physical security and exacerbated weaknesses in our economy. The priorities of the nation drastically changed in a matter of a few hours. This budget reflects the change in priorities and three primary goals: winning the war on terrorism, protecting the homeland, and reviving our economy.

Recognizing that science must play a role in these priorities, the President provides for an unprecedented level of investment in federal R&D. This is the first time in history that a president has requested an R&D budget greater than $100 billion. The precise figure is $111.8 billion, up eight percent overall from fiscal year 2002. This is the largest requested increase for R&D in over a decade.

Additionally, the federal science and technology category is up nine percent. I wanted to explain that this is a compilation—this federal science and technology category contains expenditures in a

set of fields originally proposed by the National Academy of Sciences to more accurately reflect science and technology expenditures. It accounts for nearly all of federal basic research and over 80 percent of federal applied research and about half of civilian development.

Mr. Chairman, this is a good budget for science, and I look forward to working with Congress to see it successfully enacted.

These science and technology investments will enable the Administration to enhance homeland security, national security, and global stability, to promote long-term economic growth that creates high-wage jobs, support a healthy, educated citizenry, harness information technology, improve environmental quality, and maintain world leadership in science, engineering, and mathematics.

So let me direct your attention to some specifics within this budget. Because many agencies contribute to the overall science missions, the most important cross-cutting themes have been identified, and there are budgets compiled across all agencies. While my written testimony provides snapshots of the R&D budgets of the agencies under this committee's jurisdiction, let me take a moment to describe the Administration's cross-cutting efforts in R&D.

First, information technology, nanotechnology, and health research continue to be high priorities for our nation. The past year has seen an increase in priority for climate-change R&D.

At the top of the list, however, not surprisingly, is anti-terrorism. Our success in preventing, detecting, and responding to terrorist activities over the long-term will depend on technology. The President's 2003 budget continues the Administration's strong support of research and development to counter emerging terrorist threats by increasing R&D funding for homeland security and combating terrorism, including protecting critical infrastructure, from nearly $1 billion in 2002 to an estimated $3 billion in 2003.

In nanotechnology, R&D will increase by 17 percent over last year. This $679 million multi-agency initiative focuses on long-term research on the manipulation of matter down to the atomic and molecular levels giving us unprecedented opportunities for new classes of devices as small as molecules, and machines as small as human cells.

In networking and information technology, another cross-cutting area, R&D will increase by three percent. This brings the overall investment to $1.9 billion in this mature, but still critically important area. It provides the base technologies to ensure that the U.S. maintains its dominant position in the application of information technology to critical national defense and national security needs as well as to scientific research, education, and economic innovation.

Improving human health is a major priority. Although not aggregated as a cross-cutting budget category, health research draws on capabilities of many agencies. During the presidential campaign, the President promised to double the budget of NIH by 2003 from its 1998 levels. That commitment is met in this budget, which includes the final installment of a $3.9 billion increase paving the way toward better diagnostics, treatments, and cures that affect the lives of all Americans.

Climate change research, finally, has become an important driver for the nation's research agenda. Two new initiatives, the climate-change research initiative will receive $40 million to be shared among five agencies, and the National Climate Change Technology Initiative is designated to receive $40 million within the Department of Energy budget. The ongoing U.S. Global Change Research Program will receive $1.7 billion, a $44 million or 3 percent increase.

In addition to funding these priority areas, the budget also emphasizes the effectiveness of the dollars spent. The agency's scorecard approach is still at the experimental stage this year, at least for science budgets. Although only one agency achieved the green light in any category, I'm pleased that it was the National Science Foundation.

The President's management agenda is as relevant to science missions as to other agency operations, and I look forward to working with OMB to make its provisions a useful tool for these agencies.

Mr. Chairman, I hope that this brief overview, combined with my written statement, conveys to you the extent of this Administration's commitment to advancing science and technology in the national interest. I appreciate very much the longstanding bipartisan support of this committee for the Office of Science and Technology Policy and for the science and technology research enterprise, and I would be pleased to respond to specific questions about this budget or any other matter.

[The prepared statement of Dr. Marburger follows:]

PREPARED STATEMENT OF HON. JOHN MARBURGER, PH.D., DIRECTOR OF THE OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Mr. Chairman and Members of the Subcommittee, I am pleased to appear before you today to discuss the President's Fiscal Year 2003 budget request for research and development.

When I testified prior to my confirmation by your Subcommittee last October, I expressed my desire to "form a close and productive relationship with Congress, which has long provided bipartisan and enduring support of our world-leading science and engineering enterprise. The counsel and support of Members of Congress is an essential element of continued U.S. leadership across the frontiers of scientific knowledge." I look forward to working with you, Mr. Chairman, and your Subcommittee, to demonstrate this commitment to science and engineering excellence once again this year. President Bush has set forth an agenda for science funding in the forthcoming fiscal year that takes advantage of important opportunities for discovery and development and sustains the basic machinery of research and development that will be necessary for continued national leadership in science and technology.

Last October I also referred to the fact that we must make important choices together because we have neither unlimited resources nor a monopoly of the world's scientific talent. I continue to believe that wise choices among the multitudes of possible research programs are necessary and that we must decide which programs to launch, encourage, and enhance and which ones to modify, reevaluate, or redirect in keeping with our national needs and capabilities. The President's FY 2003 Budget includes principles that will improve the management of the Nation's science and technology enterprise, taking advantage of best practices, and emphasizing the importance of good planning, execution, reinforcement of good performance, and changing poor performance. I look forward to working with Congress to ensure that the federal government's significant investment, now over $100 billion, is deployed to optimal effect.

PRESIDENT BUSH'S FY 2003 R&D BUDGET

Shortly after I was confirmed as Director of the Office of Science and Technology Policy at the end of October, the Director of the Office of Management and Budget invited me to attend internal OMB decision-making sessions involving science programs. This series of meetings gave me a greater appreciation for the issues and an opportunity to represent the science perspective on important aspects of the forthcoming budget, such as increased accountability and performance measures for R&D agencies. Following these meetings, my office has continued to work closely with OMB to share information and develop a mutual understanding of the complex issues involved in establishing the Nation's science and technology budgets.

As you well know, agency budget proposals are submitted to OMB in mid-September for their review. The terrorist attacks on September 11 dramatically changed the context for this budget. The attacks laid bare vulnerabilities in our physical security and exacerbated weaknesses in our economy. The priorities of the Nation drastically changed in a matter of hours.

The budget reflects the change in priorities and three primary goals:

- Winning the war on terrorism;
- Protecting the homeland;
- Reviving our economy.

Recognizing that science must play a role in these priorities, the President provides for an unprecedented level of investment in federal R&D, marking the first time in history that a President has requested an R&D budget greater than $100 billion. At $112 billion, up 8 percent overall from last year, this is the largest requested increase for R&D in over a decade.

The R&D budget is an imperfect measure of support for traditional science and technology activities. Another compilation, the Federal Science and Technology Budget, was originally proposed by the National Academy of Sciences to highlight the federal investment in research programs central to the creation of new knowledge. In this "FS&T" portfolio, the President's budget is up 9 percent. The FS&T activities account for nearly all of federal basic research, over 80 percent of federal applied research, and about half of civilian development, in addition to some other activities such as training and education in some R&D agencies.

Mr. Chairman, this is a good budget for science, and I look forward to working with Congress to see it successfully enacted.

These science and technology investments will enable the Nation to:

- Enhance homeland security, national security, and global stability;
- Promote long-term economic growth that creates high-wage jobs;
- Support a healthy, educated citizenry;
- Harness information technology;
- Improve environmental quality; and
- Maintain world leadership in science, engineering, and mathematics.

Now let me direct your attention to some specifics within this budget.

Interagency Initiatives

The budget increases funding for a number of priority research areas that require multi-agency efforts. Information technology, nanotechnology, and health research continue to be high priorities for our Nation. The past year also has seen an increase in priority for climate change R&D. After the events of September 11th, antiterrorism efforts naturally lead the list.

- **Antiterrorism**—our success in preventing, detecting, and responding to terrorist activities over the long term will depend on technology. The President's FY 2003 Budget continues the Administration's strong support of research and development to counter emerging terrorist threats by increasing R&D funding for homeland security and combating terrorism (including protecting critical infrastructure) from nearly $1 billion in 2002 to an estimated $3 billion in 2003.
- **The National Nanotechnology Initiative** will increase by 17 percent over last year. This $679 million multi-agency initiative focuses on long-term research on the manipulation of matter at the atomic and molecular levels, giving us unprecedented opportunities for new classes of devices as small as molecules and machines as small as human cells.
- **Networking and Information Technology R&D** will increase by 3 percent. This brings the overall investment to $1.9 billion in this mature, but still critically important area. It provides the base technologies necessary for the U.S. to maintain its dominant position in the application of information technology

to critical national defense and national security needs, as well as to scientific research, education, and economic innovation.

- **Improving human health** depends on health research that draws on the capabilities of many agencies. During the Presidential campaign, the President promised to double the budget of the National Institutes of Health (NIH) by 2003 from its 1998 levels. That commitment is met in this budget, which includes the final installment, a $3.9 billion increase, paving the way toward better diagnostics, treatments, and cures that affect the lives of all Americans.
- **Climate Change** research has become an important driver for the Nation's research agenda. The President created two new initiatives in this budget. The Climate Change Research Initiative will share $40 million among five agencies, and the National Climate Change Technology Initiative will receive $40 million within the DOE budget. The ongoing U.S. Global Change Research Program will receive $1.7 billion, a $44 million (3 percent) increase.

Highlights of Agency FS&T Budgets

The following examples provide a snapshot of the Administration's S&T request within the agencies under the jurisdiction of the Subcommittee.

- **National Aeronautics and Space Administration (NASA).** The budget provides $8.7 billion (an 8 percent increase) for NASA's programs in the FS&T budget, including $3.4 billion for Space Science (a 13 percent increase) and $2.9 billion for Aerospace Technology. The latter includes planned funding increases for NASA's Space Launch Initiative ($759 million), which will lead to safer and lower cost commercial launch vehicles to replace the Space Shuttle.
- **National Science Foundation (NSF).** The budget provides a $241 million increase (5 percent) for NSF. This increase will provide $678 million for NSF's lead role in the Networking and Information Technology R&D program, and $221 million for NSF's lead role in the National Nanotechnology Initiative. The President's Math and Science Partnerships Initiative, aimed at increasing the quality of math and science education in Grades K–12, will increase by $40 million to $200 million. The budget also raises graduate level stipends from $21,500 to $25,000 annually, in order to further attract and retain the most promising U.S. students into graduate level science and engineering. NSF is very effective at managing competitive research programs, and the budget proposes transferring to NSF programs that will benefit from their effective management. These programs include Sea Grant from the National Oceanic and Atmospheric Administration, Water Quality Research from the U.S. Geological Survey, and Environmental Education from the Environmental Protection Agency.
- **Department of Energy (DOE).** The budget provides $5 billion for DOE's programs in the FS&T budget. The budget includes a 1.5 percent increase for DOE's science programs, as well as continued support for construction and operation of large scientific user facilities, including the Spallation Neutron Source. The budget also includes a $22 million increase (up 6 percent) to DOE's Renewable Energy programs.
- **Department of Commerce (DOC).** The budget includes $861 million for DOC programs in the FS&T budget. It provides $402 million (an increase of over 20 percent) for research and physical improvements at NIST's Measurement and Standards Laboratories, and $107 million for NIST's Advanced Technology Program to promote competitive, cost-shared R&D partnerships. The FS&T budget also provides $297 million for NOAA to improve understanding of climate change, weather and air quality, and ocean processes.
- **Department of Transportation (DOT).** The budget provides $548 million for DOT's programs in the FS&T budget, including $421 million to support research to improve the quality and safety of the Nation's highway transportation infrastructure, and $95 million for aviation security technology research.
- **Environmental Protection Agency (EPA).** The budget provides $797 million (a 6 percent increase) for EPA's programs in the FS&T budget. The EPA budget funds research that provides a sound scientific and technical foundation for environmental policy and regulatory decision-making. The budget includes $75 million for R&D in technologies and procedures to cope with future biological or chemical incidents.

In addition to the agencies that fall within your Subcommittee's jurisdiction Mr. Chairman, the Department of Defense R&D efforts increase $5.4 billion (an 11 per-

cent increase) to $54.5 billion and the National Institutes of Health budget increases by $3.9 billion (a 17 percent increase) to $27.3 billion.

The President's Management Agenda

Beyond funding these priority areas, the budget places emphasis on spending dollars effectively. The budget includes a scorecard to rate agency performance and progress in five important management areas. Although only one agency achieved a green light in any category, I am pleased that it is the National Science Foundation. The President's Management Agenda is as relevant to science missions as to other agency operations, and I look forward to working with OMB to make its provisions a more useful tool for all the agencies.

In particular, among the provisions of the President's Management Agenda are investment criteria for research programs pilot-tested at DOE this past year. In consultation with stakeholders from agencies, industry, and academia, OMB and OSTP are broadening the use of the criteria to all types of R&D programs across the government in 2004.

Mr. Chairman and Members of the Committee, I hope that this overview has conveyed to you the extent of this Administration's commitment to advancing science and technology in the national interest. I look forward to achieving bipartisan support for a national S&T strategy that will combine the resources of industry, academia, non-profit organizations, and all levels of government to protect our citizens, advance knowledge, promote education, strengthen institutions, and develop human potential.

I ask for your support of OSTP's Fiscal Year 2003 budget request, and I also want you to know how much I appreciate the long-standing bipartisan support of this Subcommittee for the Office of Science and Technology Policy and for the science and technology enterprise. I would be pleased to answer any questions.

Senator WYDEN. Dr. Marburger, thank you. We'll have some questions in just a moment.

Dr. Colwell?

STATEMENT OF HON. RITA R. COLWELL, PH.D., DIRECTOR, NATIONAL SCIENCE FOUNDATION

Dr. COLWELL. Thank you, Mr. Chairman, Senator Allen, and Members of the Subcommittee. I thank you very much for providing this opportunity to discuss the President's budget request for the National Science Foundation.

America's present and future strength, prosperity, and global preeminence depend directly on fundamental research. Every year, the Foundation's optimal use of limited public funds has relied on two conditions. One, ensuring that our research and education investments are aimed, and continuously re-aimed, at the frontiers of understanding. And, two, certifying that virtually every dollar goes to competitive, merit-reviewed, and time-limited awards with clear criteria for success.

NSF puts the greatest share of its resources where they will do the very most good, in the nation's colleges and universities where we make our investments. In addition to generating the new ideas and defining the future, every dollar invested in those universities contributes to recruiting and training the next generation of researchers.

NSF has been proactive in implementing the President's management agenda, and we seek, and, in fact, we apply, the input from many sources to continuously improve the way we manage programs at NSF. When these conditions are met, our nation gets the most intellectual and economic leverage from its research and education investments.

The National Science Foundation is requesting $5,036,000,000 for FY 2003. That's $240 million more, or five percent more than

the previous fiscal year. For the United States to stay at the leading edge of discovery and innovation, we cannot do less.

One of the highlights of the budget is a second installment of $200 million for the national five-year $1 billion Math and Science Partnership Program. This program links local schools with colleges and universities to improve the pre-K–12 math and science education, to train teachers, and to create innovative ways to raise the performance of all students in schools.

An investment of approximately $37 million will increase annual stipends for graduate students to $25,000 to attract more of the nation's most promising students to science and engineering through the graduate fellowships. The budget also includes funding for six priority areas, including $221 million for nanotechnology research, $286 million for information technology research, and $60 million as part of a new priority area in mathematical and statistical sciences research that will ultimately advance interdisciplinary science and engineering, as well. $185 million dollars is directed toward NSF's learning for the 21st century workforce, our priority area, including $20 million to fund three or four new multi-disciplinary, multi-institutional Science of Learning Centers to enhance our understanding of how we learn, how the brain stores information, and how we can best use new information technology to promote learning.

We are also requesting $10 million to seed a new priority area in the social, behavioral, and economic sciences to explore the complex interactions between new technology and society so that we can better anticipate and prepare for their consequences.

The budget requests $79 million for research on bio-complexity in the environment. This builds on past investments to study the remarkable and dynamic web of interrelationships that arise when living things, at all levels, interact with their environment.

And research in two new areas this year, very important, microbial genome sequencing and the ecology of infectious diseases. They will help develop strategies to assess and manage risks of infectious diseases, invasive species, and biological weapons.

I should add that, as part of the Administration's new multi-agency climate change research initiative, we will implement a $15 million research program to advance understanding in highly focused areas of climate science to reduce uncertainty and to facilitate policy decisions.

The budget also includes $76 million for programs later to be transferred to NSF from NOAA, EPA, and the USGS. In large facilities, we will continue support for the next phase of the construction of the Atacama large-millimeter array, ALMA. The new construction projects in the FY 2003 budget include two prototype sites of the National Ecological Observatory Network, NEON, which will have a cost of $12 million, to analyze data to detect abrupt changes or long-term trends in the environment. The budget also requests $35 million for EarthScope to detect and investigate earthquakes, volcanic eruptions, and landslides on the North American continent.

The events following September 11 demonstrated our capacity to engage the research community in ways that are immediately responsive to national needs, and we owe this flexibility to a highly

trained scientific and engineering workforce that's capable of selecting the most challenging problems for their research. It is this flexibility enabled by the merit review system that makes ours a model of scientific support that is the envy of the world.

Mr. Chairman, if there are no objections, I would like to include, as part of my testimony, a Web site where the NSF budget summary can be found. And I'll be very pleased to respond to any questions.

Web site address for NSF FY 2003 Budget Summary, *www.nsf.gov/bfa/bud/fy2003/overview.htm*

[The prepared statement of Dr. Colwell follows:]

PREPARED STATEMENT OF HON. RITA R. COLWELL, DIRECTOR, NATIONAL SCIENCE FOUNDATION

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America's present and future strength, prosperity and global preeminence depend directly on fundamental research. Every year, the Foundation's optimal use of limited public funds has relied on two conditions—number one, ensuring that our research and education investments are aimed—and continuously re-aimed—at the frontiers of understanding. And number two, certifying that virtually every dollar goes to competitive merit-reviewed, and time-limited awards with clear criteria for success. NSF puts the greatest share of its resources where they will do the most good: in the nation's colleges and universities where, in addition to generating the truly new ideas that define the future, every dollar invested contributes to recruiting and training the next generation of researchers.

NSF has been proactive in implementing the President's Management Agenda, and we welcome—and apply—input from many sources to continuously improve the way we manage programs at NSF.

When these conditions are met, our nation gets the most intellectual and economic leverage from its research and education investments.

The National Science Foundation is requesting $5.036 billion for FY2003, $240 million or five percent more than the previous fiscal year. For the United States to stay on the leading edge of discovery and innovation, we cannot do less.

Before providing a few highlights of the budget, let me stress that the priority setting process at NSF results from continual consultation with the research community. New programs are added or enhanced only after seeking the combined expertise and experience of the science and engineering community, the Director and Deputy, and the National Science Board.

Programs are initiated or enlarged based on considerations of their intellectual merit, broader impacts of the research, the importance to science and engineering, balance across fields and disciplines, and synergy with research in other agencies and nations. NSF coordinates its research with our sister research agencies both informally—by program officers being actively informed of other agencies' programs—and formally, through interagency agreements that spell out the various agency roles in research activities. Moreover, through our Committee of Visitors process there is continuous evaluation and feedback of information about how NSF programs are performing.

One of the highlights of the budget is a second installment of $200 million for the national five-year, $1 billion Math and Science Partnership Program. The program links local schools with colleges and universities to improve pre-K–12 math and science education, train teachers, and create innovative ways to raise the performance of all students and schools.

An investment of approximately $37 million will increase annual stipends for graduate fellows to $25,000 to attract more of the nation's most promising students to science and engineering.

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how the brain stores information, and how we can best use new information technology to promote learning.

We are also requesting $10 million to seed a new priority area in the social, behavioral, and economic sciences to explore the complex interactions between new technology and society so that we can better anticipate and prepare for their consequences.

The budget requests $79 million for research on biocomplexity in the environment. This builds upon past investments to study the remarkable and dynamic web of interrelationships that arise when living things at all levels interact with their environment. Research in two new areas this year—microbial genome sequencing and ecology of infectious diseases—will help develop strategies to assess and manage the risks of infectious diseases, invasive species, and biological weapons.

I should add that as part of the Administration's new multi-agency Climate Change Research Initiative, we will implement a $15 million research program to advance understanding in highly focused areas of climate science, to reduce uncertainty and facilitate policy decisions. Our budget also includes $76 million for programs slated to be transferred to NSF from NOAA, EPA, and the USGS.

Although we did not seek these transfers, we take considerable pride in the fact that of the 26 Federal agencies judged by OMB in five key management areas, only the National Science Foundation received a green light. NSF is noted for its expertise and success in funding competitive research, and this was certainly a factor in this recognition. Sea Grant, which originated at NSF, is a valuable program; and should Congress and the Administration agree to such a shift, we would, of course, do our best to make it even more effective.

In large facilities, we will continue support for the next phase of construction of the Atacama Large Millimeter Array (ALMA). New construction projects in the FY2003 budget include two prototype sites of the National Ecological Observatory Network (NEON) at a cost of $12 million to analyze data to detect abrupt changes or long-term trends in the environment. The budget also requests $35 million for EarthScope to detect and investigate earthquakes, volcanic eruptions, and landslides on the North American continent.

The events following September 11 demonstrated our capacity to engage the research community in ways that are immediately responsive to national needs. We owe this flexibility to a highly trained scientific and engineering workforce capable of selecting the most interesting and challenging problems for their research. It is this flexibility, enabled by the merit review system, that makes ours a model of scientific support that is the envy of the world.

Mr. Chairman, I would be pleased to respond to any questions that the Committee may have.

Senator WYDEN. Okay, thank you, Dr. Colwell and thank you both. Both of you have cooperated very closely with this Subcommittee, and we appreciate it.

Let me begin with you, Dr. Marburger. You know of my admiration for you and your work, and let me start with a few questions that I am really concerned about.

I think that when you look at the research budget in the Administration's proposal, despite your good work and your good efforts, it really lacks balance. It doesn't have the kind of across-the-board commitments that we're going to need to do what this country is counting on in the research area. And let me be specific about it.

As I look at the research budget, basically all of the increase requested for fiscal year 2003 is accounted for by NIH and DOD, and I think we need a much more balanced portfolio and we need increases in other key kinds of areas. Now, I know you're just one person battling for this, and I sort of feel badly about putting you on the spot here, but what can we do, working on a bipartisan basis, to get a more balanced portfolio and get these increases that are so important to the well being of the country?

Dr. MARBURGER. Well, first of all, Senator, I think that we should be careful not to assume that the President is not also concerned about balance. But this is an Administration that tries to

establish priorities and make funding choices that are sometimes difficult. The President has asked for a lot of money for a very important area of science in which there are significant opportunities for discovery, and that's in medical research and the life sciences.

I would like to point out that, although some feel that there's a lack of recognition that life sciences depend on physical science support, the National Institutes of Health do pay for approximately 15 percent of the physical science budget. NSF supports about 12 percent of the physical sciences budget. The Department of Energy owns about 38 percent; NASA, 22 percent.

So the situation with respect to the sources of funding and the balance issue is actually rather complicated, and I do believe that it's important to have management mechanisms in place that give us detailed recommendations about how money should be directed.

Within the President's budget proposal, choices have been made. The life sciences do get a big increase, but other areas get increases which are not negligible.

Now, I hesitate to offer numbers that are different from the ones that you mentioned in your opening statement, but my understanding is that the increase to the National Science Foundation, including the transfers to which—you've objected to some of them—is five percent. And if you exclude the transfers, it's 3.4 percent.

Now, if you remove from the science budget the amount for the increase for NIH and the very substantial and admittedly largely development-oriented increases for the Department of Defense, what's left is two percent for the remaining parts of the science budget. So a 3.4 percent increase for the National Science Foundation does represent something substantially above what might be expected to be available for this budget.

Within that 3.4 percent increase, further priorities have been established. I mentioned nanotechnology, which gets a 17 percent increase, the mathematics and statistics category that Dr. Colwell just mentioned is doubled, and there are other similar priorities that have been identified and addressed.

And I also, in my statement, suggested that the priorities expressed in this budget are overall priorities for the nation. It's important for us to keep in mind that the large increase for the National Institutes of Health includes approximately half or more than half that would go to address issues in bio-terrorism.

So there is a great deal of concern about the balance issue, but there is also a desire to establish well-defined priorities and to make hard decisions and fund them. I do expect that the balance issue will continue to be addressed by this Administration in subsequent years, and I pray that the economy and the war against terrorism both will go well, and we'll be able to afford to do everything that we would like to do.

Thank you.

Senator WYDEN. I think those are fair points, and I don't want to belabor this, especially with someone I admire. I think my concern, and I think the concern in the scientific community, is, even the 3.4—apparently that is an overall increase, not just in the research area. And even if you were to take the 3.4, you're basically talking about cost of living. And, again, this is a discussion—you're the last person I want to have this with, because you have been

so cooperative in working with us, and I have great admiration for the work you're doing. I think we ought to just, as Senator Allen has tried to do, work to try to get the most balanced portfolio that we possibly can, because we've got a lot of work to do.

And I want to ask only one other one on this round, and then I'm going to recognize my colleague and come back in a minute.

I think, Dr. Marburger, that we have what amounts to a crisis in terms of science and math education. I mean, you see it by way of so many measures. The National Science Board, for example, recently reported that in cross-national comparisons of math and science achievement, U.S. high school students continue to fall below international averages. We have an aging workforce, in terms of those that are equipped with science and engineering. This is really a defining moment, it seems to me, in our country's history with respect to science and math, and I think I would like to get a sense of what your long-term strategy is with respect to science, math, and engineering education, because I think these are national security questions. Just as sure as the night follows the day, if we don't make investments in programs that work here, this really puts at risk this country's national security. And why don't you give me your thoughts on what our long-term policy in this area ought to be?

Dr. MARBURGER. I would love to, Mr. Chairman. My thoughts are very similar to yours. I think this is an extremely important area and problem for this country. The President, as you know, has spoken frequently—almost every other time I see him on television, he's in a classroom and urging the importance of education for the strength and future strength of our nation.

I believe that investments that are being made in, for example, the math and science partnerships and other programs through the National Science Foundation, are wise investments and are very interesting in that they try to bring some of the finest minds that we have in our excellent research universities and other universities elsewhere into the K–12 experience, working in cooperation with school districts, trying to enrich the science and math experience that young people have and bring them into contact with people who are actually doing research, because there is nothing more exciting than to be in personal touch with someone who loves their work and simply exhibits the joy as well as the rewards of discovery in science and engineering.

So this is an area where ideas are welcome. We need to invest more heavily in research on the best teaching methods. We need to understand exactly what's happening in the classroom so that we can improve on practice. And I believe this Administration is prepared to make the investments that are necessary for these improvements.

Senator WYDEN. I'll have some additional questions in a moment.

Senator ALLEN?

Senator ALLEN. Thank you, Mr. Chairman. First, thank you both for your statements. And there's going to be some slight differences in balances as the executive proposing legislative branch, getting their views on it. But I think, on balance, this is an outstanding and an unprecedented opening proposal from this Administration. I want to commend you all for your influence and that of the Presi-

dent, as well, on recognizing the importance of research and funding that research.

I'd like to ask a few questions on some of the details, some larger questions. First, let me start with you, Dr. Marburger. In the 1990s, we learned about innovation and capital formation, intellectual property, licensing, speed-to-market. According to one estimate, there's as much as $9 trillion worth of ideas that are confined in universities, national labs, and corporations. Their originators are constrained, you hear from time to time, by bureaucracy, from dispersing these ideas and, thus, bolstering the economic and the social value of these innovations, many of them, patent-able intellectual property ideas.

I know you're a former national lab director. What changes to the existing policies and laws would you suggest to make our innovation system more efficient and free up some of these ideas and innovations?

Dr. MARBURGER. Senator, that's a very big question, and I'd like to respond partially to that in writing so that you can——

Senator ALLEN. Okay.

Dr. MARBURGER.—get the full——

Senator ALLEN. I'd love to have it in writing.

Dr. MARBURGER. But I would say——

Senator ALLEN. I can't take all the notes down.

Dr. MARBURGER.—that under the President's Council of Advisors in Science and Technology, PCAST, which I co-chair with Floyd Kvamme, the President has asked us to make recommendations to him regarding strategies for improving the effectiveness of investments in federal research and development funds to universities.

A subcommittee has been formed, chaired by President Wayne Clough, of Georgia Tech, whose first task is to look at technology transfer, and, in particular, some of the existing legislation that affects technology transfer in universities and from higher education. They're looking at the Bayh–Dole Act, and they're looking at practices of universities, how they're taking advantage, or not, of the Bayh–Dole Act, and other possible impediments to the technology transfer process. That report should be out in a few months, and I'm looking forward very much to getting the ideas of this subpanel, and I would hope that we can all learn from the experience of the people on the panel.

For my own part, I have witnessed a great deal of interest in the investment community and in the private sector in gaining access to this technology. There are, of course, many stories here that we can learn from. One important thing to note is that the larger industries, the IBMs and the Intels and the Monsantos and the pharmaceutical companies, understand better how to gain access to this technology, and they take advantage of it more. The smaller businesses have a harder time dealing with the regulations and the bureaucracy and red tape that has grown up over the intellectual property issues.

So I think there is room for some improvements in the process. And I don't have any magic bullet or sweeping recommendations, but I believe that if we pay attention to this, we can discover ways to improve the system, and I would look forward to working with you to do that.

Senator ALLEN. Thank you, Dr. Marburger. I didn't expect you to have all the answers right now, but it is important that we do work together on that. I've heard it from universities, as well, and certain things that can be improved.

Let me get your views, Dr. Marburger, on something much more specific. In your written statement, you indicated that there's $2.9 billion allocated for aerospace technology at NASA. We had a hearing recently, within the last few weeks, on the NASA budget, and our analysis showed that imbedded in the aerospace-technology funding there is a ten-percent reduction in aeronautical research. Now, in aeronautical research, we have the same problems we're talking about, an aging workforce. We're worrying about airline and aircraft security. Aeronautical research is important there.

Then another aspect I'd like you to comment on with this ten-percent reduction in aeronautical research is the fact that the European Union has declared they're going to take over the aviation market, and they've done a good job in it, in getting it from about 10 or 20 percent to now about 50 percent of the market. They've invested a great deal.

Money is not the only answer, but we do need to have those funds to have those scientists, the engineers doing the research, to get to the next generation of aircraft as well as the technologies to improve the efficiency, the quietness, in some cases, and to expand, also, the capabilities of existing air space. What is your view on how this is going to help us become more competitive with a ten-percent reduction in aeronautical research?

Dr. MARBURGER. Well, let me address the ten-percent reduction first, Senator. Funding for the federal science and technology at the Department of Transportation declines in this budget primarily within FAA relative to a supplemental funding increase of $50 million in 2002. Some R&D programs that have been at FAA will now be funded through the Transportation Security Administration. So we would want to look at the—at how this ten-percent relates to these changes in budgeting. And because, in fact, aviation research is important to this Administration, we do want our airline industry, our civil aviation industry, to be competitive. I spend a portion of my time meeting with representatives of this industry and on their issues, and we also staff and strongly support a special commission on commercial aviation that is chaired by former Congressman Walker. So this is a priority for us, and we are interested in making appropriate resources available to the industry and to agencies that support it.

I would say that, with respect to European plans for dominating the civil aviation market by 2020, with a substantial increase in funding, we don't make our funding decisions for aeronautics research on the basis of overall levels of foreign spending in that field. Instead, decisions on different aeronautics research activities are based on merit, and they're designed to achieve key multi-year goals to improve the nation's air system.

There's a lot more that we can say about that, because we've been working on this issue, and I would be willing to add more in written testimony. But I would just want to be careful about the numbers and to indicate that we do care about this, and we're trying to do it right.

Senator ALLEN. Well, thank you, Dr. Marburger. NASA's not necessarily your budget, but this is an important research aspect. And let me say that I have yet to be convinced. I certainly have an open mind and want to be listening to it. Please also understand that I am competitive by nature, and I don't like losing, especially something as important as aviation, which is important for security, it's important for our commerce and our aviation and aeronautical leadership. It's absolutely essential for national security. But for our superiority in the air, if we had to fight this war on terrorism in Afghanistan, or, for that matter, even Operation Desert Storm, the way wars were fought previously, without technology, especially the air superiority, that means more men and women in uniform would have perished. And so it is important for our national security, not that I consider the Europeans to be anything but allies. I'm one good supporter of NATO and would like to expand it, as well, but that's another committee issue.

But the point is, you don't just find people to get back up to speed in aeronautics. You have an aging workforce there, and if that funding drops, it's not something that you just have somebody come in and train them in a few months. It takes many, many years and disciplines and education. And I'm worried that we're going the wrong direction. I don't expect us to spend what the Europeans spend, but I don't think we ought to be reducing it. And a lot of the NASA focus is not—there's several A's in NASA. There's space, there's also aeronautics, and that cannot be ignored. That's another balance, but it's a balance in research.

Let me ask Dr. Colwell a question that also bears out what was mentioned by Dr. Marburger. I'm certainly supportive of the nanotechnology initiative. I think that's very important, and I'm glad to see we're increasing funding in that cutting-edge research in that field of nanotechnology. However, as you know, we need to be careful not to neglect engineering, physics, and other core sciences. What can the National Science Foundation do to maintain the proper balance between these interests?

Dr. COLWELL. You touch on a very important and a very critical issue, the decline in numbers of students getting degrees in engineering and the disturbing data that show that as many as 45 percent of the graduate degrees in engineering are going to foreign students. In the past, we could anticipate that they would all stay in this country. We cannot anticipate that any longer. Many are being recruited, as Dr. Marburger and I noted, on a visit to China recently, that the Chinese are actively recruiting the many students who are currently in the United States, both Chinese-American citizens, but also Chinese students who are on student visas.

Thus it is critical that we address the physics, math, engineering areas. Mathematics is one area that we are definitely addressing. We've doubled the budget for mathematics. Over the last four years, the budget has gone from $90 million to $182 million dollars for mathematics, and that still needs to be further increased, in out years, because mathematics cuts across every single discipline.

We will address physics and engineering needs in future budgets. Right now, it's level for chemistry. But if you take into account the instrumentation that's provided for physics and astronomy research, it does represent a very large increase for mathematical

and physical sciences. We are very pleased to be funding ALMA and to continue funding the Large Hadron collider.

To put it in proper perspective, another kind of balance has to be addressed, Senator, and that's people, ideas, and the tools to work with. We're desperately trying to achieve that kind of balancing for these very critical needs.

Senator ALLEN. Thank you, Dr. Colwell. No further questions.

Senator WYDEN. I thank my colleague. And just a couple more, and then we'll excuse you. You all have been very patient.

To pick up on this question of additional funding, there's going to be a big push, Dr. Colwell, in terms of doubling the funding for your agency. Give me a sense of how you would distribute money, in terms of the priority that you would fund first, what you fund second, and then take it all the way up to the Valhalla of having funding doubled.

Dr. COLWELL. Let me say that we can always use additional funds for science and engineering. I'm a scientist, and I couldn't say anything except that.

The core areas of funding are very important and would be a very top priority. When I became NSF Director, in my very first speech, I said that my biggest challenge would be to address the opportunities in interdisciplinary research, but, at the same time, to maintain the strengths of the disciplines, because without strong disciplines, you don't have good interdisciplinary research. They go hand in hand. The disciplines really need to be addressed.

I'm very concerned about maintaining leadership in information technology and certainly in nanotechnology. I've just returned from Japan at a meeting of the G–8 nations of Heads of Science Councils, and learned that Japan, alone, is investing $900 million in nanotechnology. This is an area that really portends the future. We have to be the leaders and maintain leadership.

Biocomplexity—we've got to understand the workings of the environment. We've got to have scientific principles applied to environmental research. Biocomplexity of the environment is understanding how organisms in the physical environment interact and how all components of the earth system comprise a "living system," if you will. We are very pleased that we have in the budget, in the climate initiative, funds to address risk and also funds to address carbon cycling, one of the unanswered questions that needs to be pursued. Putting science into understanding the environment is critical.

The workforce is a major issue. We are doing all we can to address this, bringing interest in science to children. The pre-K–12 program, graduate students working with teachers in the elementary, middle, and high schools. The program is working very well. It brings the content of science and engineering, but also the excitement, and it brings a big-sister/big-brother approach—not big brother in the political sense, but in the familial sense—to children so that they relate to someone closer to them in age, to share the excitement of science. For example, a seven-year-old will learn that an engineer does work other than drive trains.

We're working on building Science of Learning Centers, to study the science of teaching and learning, to enhance teaching. Forty percent of our science teachers have not majored in science. We've

got a lot of work to do. The National Science Foundation is working hard.

My vision for the Science Foundation is that it will continue to be the very best science agency in the world, because we do know—and I have met with overseas visitors to NSF who are converting their approach to science and engineering to that of merit review as done at NSF. They are incorporating the merit review process we use.

Obviously, I could go on for a long time, because you've asked me about a subject I care deeply about. There are priorities we are addressing and that we will continue to address.

Senator WYDEN. Dr. Colwell, as you know, the Inspector General issued a fairly critical report on the major research equipment account, and I think we've got to get your response on the record to that.

Dr. COLWELL. Yes. I would have to say that I've always dealt openly with Congress. We strongly disagree with the examples that the IG cited in the report. We take exception with the assumption that costs of major research improvement can easily and readily be characterized or allocated in only one permissible manner.

Let me assure you there have been no misapplication of funds. We are developing a comprehensive response that we will send to this Subcommittee by June 15th. And once all the facts are on the table, I'm confident you will be satisfied. There is no reason to doubt NSF's longstanding reputation for integrity.

We are able to stay within our authorized funding limits. The statement by the IG is inaccurate and incorrect. No matter what definition of "full cost accounting" is used to evaluate our facilities, we can provide the total, complete cost of any project. Our methods are transparent. There are no hidden costs, no misapplication of funds. We have always consulted with the National Science Board and the Congress about any questions that have arisen in the course of constructing major scientific facilities.

It's important to remember that it's inherently difficult to develop standardized definitions and plans for facilities whose purpose is to redefine the state of the art. But I will say that improvement at NSF is always possible, and it's desirable. Although we disagree with the IG's examples, nonetheless, we are in agreement with the general direction of the reports' recommendations.

But keep in mind a number of points. The major research facility guidelines have evolved over time since the account was first created in 1994. We have built hundreds of millions of dollars worth of world-class scientific facilities, and we've always tried to learn from those experiences and then apply the best practices.

We are now proceeding to update our procedures for facilities oversight to meet the future demands for the increasingly complex projects, and we look forward to sharing our ideas with you in how we can administer the construction, the operation, and management of NSF's large facilities.

Finally, let me underline this. We pledge our very best efforts to work cooperatively and openly with the IG. I'm fully confident that we can resolve those differences, and we'd welcome the guidance and help of Congress in that effort on how best to interpret certain

ambiguous technical issues. Then all of us can more profitably focus our full efforts on the future.

Senator WYDEN. One gets the sense that you anticipated that question.

Senator WYDEN. And, on a serious note, I think it's clear that this is important, because those of us who do want to increase your funding, it chips away at our credibility if we've got the IG talking about full cost accounting and various other arcane kind of things. So I appreciate your going after it and giving to Senator Allen and myself that answer by middle of next month would be great.

One last question, and then we'll excuse you, and you all have been very patient.

Dr. Marburger, probably more than anything else in the technology areas as it relates to homeland security, I want to make sure that for the businesses and the entrepreneurs and the scientists in this country who have a promising idea, that they've got one contact point in the federal government. And as you know, in the NetGuard proposal, most of the attention has largely focused on mobilizing the scientists and the entrepreneurs and making sure that when Intel or Microsoft sends significant equipment and personnel to a disaster site, that those resources are used well. But the part of that bill that I think is also going to make a huge difference is the center, the one-stop shopping, so to speak, for making sure that entrepreneurs can get these technologies evaluated.

Tell me a little bit how you see that working with the group that's in place now, the Technical Support Working Group. As you know, we talked a lot about that as were drafting the bill—your folks and Senator Allen's and mine. I think we've got a good fit, you know, now and something that builds on what the Administration is doing. But because this is an area I do feel strongly about, I just do not want to see entrepreneurs spending time and money traipsing all over the federal government and going through these bureaucratic, you know, horror stories that have been told to us when they've got promising ideas. And I think we've got it right now, but I'd like to close this panel by having you give us your assessment on that point.

Dr. MARBURGER. Good. Mr. Chairman, as you know, we've learned something from your own ideas about this. Shortly after the events of 9/11, every agency analyzed their capabilities for immediate homeland response, and many started programs. National Science Foundation funded some important projects within weeks—with days, perhaps—of the attacks, and these were very valuable. But one, in particular, impressed us, impressed the people in my office that had experience with this, and this was the Technical Support Working Group that you've alluded to that was jointly chaired by the Department of State and the Department of Defense. They had a procurement and a review process that seemed to us to work quite well and would now be an important part of a one-stop shopping concept.

There's currently a proposal circulating within our office and the Office of Homeland Security that would handle this. Broadly defined, one of the elements of the proposal is the establishment of a central web site that would contain agency information, links to agency solicitations and points of contacts, and instructions for sub-

mitting new ideas to an R&D clearinghouse. And this is your concept.

We're also discussing the establishment of a central clearinghouse that might be managed by a group within the Department of Defense that already has an established system for reviewing such technical proposals, which is the Technical Support Working Group. And we would broaden the mission of that group. It would solicit, review and respond to unsolicited ideas across broad categories of homeland security, not just the ones that they're considering now.

So there's a lot to say about this, but, in general, that working group would draw on expertise from agency representatives that would staff review teams—and many of these teams already exist within the Technical Support Working Group today—and they would work together to find the best home for good ideas so that a provider of service or someone with a good idea would not have to shop around. They would also ensure that there's not duplication of funding with other agency solicitations. Since it would deal only with unsolicited R&D ideas, this clearinghouse would not replace or duplicate any existing agency program's funding or responsibilities. It would simply provide a path for small businesses and entrepreneurs to get their homeland security ideas to the right people in the federal government and to make this process as straightforward as possible.

I'm optimistic about this, because we have good models for this process in government today. It's just that we don't have the kinds of overarching guidelines and coordination that this new mechanism would provide. And I'm looking forward to seeing it go into action as soon as possible.

Senator WYDEN. Very good. I think we'll excuse you, unless Senator Allen wants to ask anything else, and we'll go to our next panel.

Senator ALLEN. I just want to say the President's very fortunate to have people of your caliber leading him. Thank you for your passion and your expertise.

Senator WYDEN. Both of you have been very helpful as we've gone forward with our work. I'm looking forward, particularly, to having a signing ceremony on the cyber-security and NetGuard proposals. This will give us a chance to mobilize the science and technology sector at a time when we're mobilizing so many other Americans to fight terrorism, and you all have played a key role in helping us to get this far, and we're going to finish the job. We look forward to working with you, and we'll excuse you at this time.

Dr. COLWELL. Thank you very much.

Dr. MARBURGER. Thank you.

Senator WYDEN. All right. Our next panel is Speaker Gingrich, with The Gingrich Group, in Atlanta, Georgia, Mr. John Podesta, visiting professor of law at Georgetown Law Center, Dr. Alan Leshner, Chief Executive Officer of the American Association for the Advancement of Science; Mr. Thomas McCoy, of Montana State University; and Dr. Marsha Torr of the Virginia Commonwealth University.

Well, thank you all very much, and this is exciting to see this panel. And I think it's illustrative of the fact that you can have some debates in this town and some really ferocious discussions where the decibel level gets awfully high. But to see the Speaker and Mr. Podesta, for example, two of the most prominent political figures in this country—one a Republican, one a Democrat—unite behind these science questions is really a very encouraging development. We're going to make your prepared remarks a part of the record in their entirely.

Mr. Speaker, why don't you begin, and then we'll go to you, Mr. Podesta.

STATEMENT OF HON. NEWT GINGRICH, CHIEF EXECUTIVE OFFICER, THE GINGRICH GROUP

Mr. GINGRICH. Well, let me just, first of all, commend you, Chairman Wyden and Senator Allen, for holding this vital hearing and focusing on the right topic.

As you know, the Hart–Rudman Commission on National Security to 2025, which President Clinton created, warned that our failure to invest in science and to reform math and science education was the second-biggest threat to our national security. It warned that only the threat of a weapon of mass destruction in an American city was a greater danger. In fact, the commission unanimously concluded that the danger from under-investing in math and science and failing to reform math and science education was greater than the danger from any conceivable conventional war in the next quarter century.

This is compounded, because the explosion of knowledge in nanoscale science and technology and the quantum behaviors associated with that scale, from smaller than one atom to about 400 atoms, represents a profound transformation in our understanding of the natural world. In fact, every member of Congress should follow this Subcommittee's leadership and take time to learn at least the basics of nanoscale activities and the potential of quantum behaviors, because they are as profound for the 21st century as the theory of relativity and the rise of nuclear physics was for the 20th century.

These changes will be so profound that they will affect biology, chemistry, physics, and the basic building blocks of every aspect of life and civilization. Our approach to health, the environment, productivity, and national security will all be profoundly shaped by this emerging revolution and knowledge.

The knowledge breakthroughs of the next 20 years will equal the entire 20th century. And this is not hyperbole. If you just take all the databases of who's at work, what's being invented, we will literally have at least the scale of breakthrough in the next 20 years that we got between 1900 and 2000. In other words, the rate of change is accelerating, and in the next two decades, it will be about five times as fast as the 20th century on a per-year basis. The rate will continue to accelerate, and we will match the 20th century again between 2020 and 2035.

Countries which fail to invest in basic science and math and which fail to insist on adequate math and science education will fall behind economically and in national security capabilities. The

United States' lead today is a function of past investments and, frankly, of past immigration to the United States of brilliant, hard-working people.

Our ability to lead in 2020 is a function of current decisions. There is no reason today to believe we will automatically maintain that lead. We graduate too many lawyers and too few scientists and engineers. We produce too few high school students capable of doing college math and science, and too few college graduates capable of doing graduate work in science and math and engineering. If the present trends continue, we will certainly be surpassed by China and India in the next generation, and we might be passed by Europe and Japan.

To meet this challenge, the National Science Foundation should be increased to a $15 billion a year budget. That is not—it does not have as big a base as NIH. And while I actively and strongly supporting doubling NIH, I think it's misnomer to assume the same scale of growth, because the National Science Foundation started out much smaller. At $15 billion a year, it would still only be 60 percent the size of NIH.

It is clear from last year's testimony that the National Science Foundation could invest $11 billion a year within current constraints based on current proposals. It is equally clear that instrumentation, education, and research projects could absorb a $15 billion a year level productively.

The National Nanotechnology Initiative should immediately be expanded to at least a billion-one-hundred-million dollars in the coming year, and should grow at a 15 to 20 percent a year rate after that. The National Institutes of Health should be instructed to invest a minimum of three percent of their research efforts into nanoscale activities.

Finally, Chairman Wyden was exactly right in referring to crisis in math, science, and engineering education. I would argue that it is as big a crisis as the terrorist threat, but it's a longer-term, more invisible crisis. But it has very profound threats for us. The math and science educational efforts at K–12 and in undergraduate collegiate education have to be thoroughly overhauled with a focus on results rather than intentions. And by that I mean if we're not producing enough kids that are doing calculus, we've got to keep reforming until we're producing enough people who can do calculus, physics, chemistry, biology, et cetera.

Reforming education in this area is a matter of national security priority, and if we fail at it, we should expect to decline as a power and to fall behind other countries within a generation.

And I very much appreciate your holding this hearing.

Senator WYDEN. Mr. Speaker, thank you for coming. And there are a lot of demands on your time, but the fact that you're willing to be here to speak out on these issues makes a real difference, and I'm very appreciative of your doing it.

Mr. GINGRICH. Mr. Chairman, may I make one last comment——

Senator WYDEN. Absolutely.

Mr. GINGRICH.—which is not quite on the topic? But just let me say I think the Congress ought to contract with the National Academy of Sciences on a paid basis, rather than recreate the Office of Technology Assessment. And I think you'd be much better served

in the long run to get sophisticated scientific advice on a regular basis, coordinate by the National Academy of Sciences, but produced on a contract basis with the Congress paying for it, not just taken out of the hides of volunteer scientists, but recognizing that if we could bring scientists directly into contact with members of Congress, we're going to get a far higher level of dialogue than if we create another organizations where staffs do analysis for us, and we end up with papers published by people who have masters degrees, rather than meeting routinely with Nobel Prize winners.

Senator WYDEN. It may be too logical for us to pursue.

[Laughter.]

Senator WYDEN. But, I mean, the bottom line that you're talking about—and I had not heard about that idea—is to make sure that at every possible opportunity you have members of Congress directly interacting with scientists, and that is clearly a winning proposition, and I'll want to follow up on that.

Mr. Podesta, we're very pleased that you could come. And after all your years in the political trenches, I suspect a lot of Americans aren't aware of all the time you have spent championing these issues, and particularly scientific policy. And thank you very much for coming, as well. And I'm so pleased to be able to have this freeze-frame of you and the Speaker sitting side by side, because this is what it's going to take to get it done. And please proceed.

STATEMENT OF JOHN D. PODESTA, VISITING PROFESSOR OF LAW, GEORGETOWN UNIVERSITY LAW CENTER

Mr. PODESTA. Well, thank you, Mr. Chairman and Senator Allen. I want to—it's a pleasure to be before the Committee to discuss the vital mission of expanding and strengthening the federal government's investment in scientific discovery. And I want to particularly thank you for letting me be to the Speaker's right in this panel.

[Laughter.]

Senator WYDEN. I was noticing that.

Mr. PODESTA. That may be a real first.

[Laughter.]

Mr. PODESTA. As you noted, while I was up here working on the Senate staff, and then throughout my career in the Clinton White House, especially as Chief of Staff, I had the privilege of being deeply involved in development of budget and policy priorities in this area. And today, as the nation is focusing on fighting the war on terrorism and strengthening our homeland security, it's important to consider how our scientific research enterprise can not only help fulfill those missions, and that mission, that vital mission, but to secure the blessing of liberty and improve the quality of life for all Americans.

A lot has been said here. I'm going to try to be brief. I'm not going to repeat what the scientific investments have already done, indeed, for improvements of health, for the environment, for economic growth, as Senator Allen pointed out, the vast and dramatic increase in productivity that was the result of the ingenuity of the private sector in America but, I think, was directly, also, the result of important investments that we made in the 1960s and 1970s and 1980s in these areas.

But it's also important, I think, to reflect on the fact that, in addition to all these areas we see at home, it has a direct and tangible impact on how we fight the war. Today, a commander in Tampa can look at a video screen and fire a Hellfire missile from a Predator flying low behind the enemy lines, and that's the direct result of the science and technology investments that we've made.

I provided the Committee with a lengthy written statement. Let me just cover the five points that I pointed the Committee to.

I believe that we ought to double the NSF budget. It's clear that that's a goal that we can and should set, that it does provide the kind of balance that both of you were talking about earlier. The Speaker has suggested an even more aggressive funding stream for the NSF. But clearly, I think, the fact that the Administration and the Congress made the commitment to double the NIH budget has kept us on track, and I commend the Bush Administration for staying on track to double the NIH budget, but we need that kind of commitment on NSF, as well. I further would like to commend the Bush Administration for an overall top line that I think is quite substantial and quite good.

But there are places I think that we can improve. NSF is one. The other that I—as I point out in my testimony is I really think we're missing the boat on energy security. We've just been through a major debate in the Senate and last summer in the House on an energy bill. If you look at the trend on climate change—and I think Dr. Colwell spoke about the—where we are and the variety of opinions on climate change—it's clear, even at the low end, we're looking at a climate increase of—a temperature increase of—at the very lowest end of prediction, of about 2.5 degrees over the next hundred years. If you compared that to less than a degree over the past thousand years, we've—that has profound national security implications with regard to clean water and agricultural production and really the production of what you might call "environmental refugees," people coming from Bangladesh, from Indonesia, from the Middle East, et cetera. We ought to be investing much more substantially in that area than I think is included in the Bush budget.

Something that might get me in a little bit of trouble up here, I would urge you—and I think this Committee has a really important role to play—to follow the Bush Administration's lead and resist the temptation to earmark research and development funding on these peer-reviewed projects. Again, as Dr. Colwell pointed out, all around the world people are looking and modeling their research portfolios against our NSF because it's peer-reviewed, because it gives the best results. And I know I'll get in trouble a little bit with our appropriators friends, but I think that you have an important mission to make sure that the NSF, as it has in the past, stays beyond that. You have a role to play in setting priorities, but these project-by-project earmarks can really eat up the budget.

I propose that you actually recreate the Office of Technology Assessment. It was de-funded in 1995 as part of the budget-balancing efforts that the Congress participated in. Against a budget of $112 billion, it seems to me you could find $20 or $30 million. If this contract research proposal is a better approach to keep you in contact with the top scientists of the country, I think that's—I'm open to

thinking about that. But clearly the Congress needs that kind of advice, and I think that some mechanism for providing it is really critical.

And then, finally, let me say that I think this Committee also has an important role to play in supporting scientific freedom and openness. I think we have seen an Administration that has a strong policy preference for tilting the balance to some extent in favor of secrecy. We're in the danger, I think, of creating a new culture of secrecy. It's bound to influence the direction of discovery, the efficient advancement of scientific knowledge, and the public's opportunity to assess the costs that come from a science program unchecked by public scrutiny.

I think we've always got to be mindful that there are secrets worth protecting. I saw that every day in the White House. But I think that overall, the progress of scientific openness is a better security paradigm than one of secrecy. So I see my yellow light on. So, with that, let me stop and turn it over to the other panelists.

[The prepared statement of Mr. Podesta follows:]

PREPARED STATEMENT OF JOHN D. PODESTA, VISITING PROFESSOR OF LAW, GEORGETOWN UNIVERSITY LAW CENTER

It is a pleasure to appear before the Committee to discuss the vital mission of expanding and strengthening the Federal Government's investment in scientific discovery. Throughout my service in the Clinton Administration, especially as White House Chief of Staff, I had the privilege of being deeply involved in the development of budget and policy priorities in this area.

Today as the nation is focused on fighting a war on terrorism and strengthening our homeland security, it is important to consider how our scientific research enterprise can not only help fulfill that mission but secure the blessing of liberty and improve the quality of life for all Americans.

Science has been on the frontlines and in the trenches of every campaign to protect America's freedom. Today's war against terrorism is no different. Watching the footage from Afghanistan, we realize that this war has not only been fought by American soldiers with guns in the caves of Tora Bora, but also by scientists in labs on American soil. We now live in a world where a commander in Tampa, Florida, watching a video screen, can unleash the fury of a Hellfire missile from an unmanned Predator flying low over enemy lines.

The events and consequences of September 11th have forced us to re-examine nearly every facet of American life. Our nation must revolutionize the way we approach national security, from bioterrorism to military readiness, to electronic surveillance and communication's security. In his September 20th address before a joint session of Congress, the President stated, "Americans are asking: How will we fight and win this war? We will direct every resource at our command—every tool of intelligence . . . every necessary weapon of war—to the disruption and to the defeat of the global terror network." By framing technological innovation in the context of national survival, the President has profoundly affected the scope and the rules by which the pace of scientific inquiry will be conducted in the United States.

This is not the first time a President has called on the scientific community to meet the country's strategic goals. Forty years ago, in the midst of another national security crisis—the Cold War—another President posed the same challenge. On September 12, 1962, President John F. Kennedy declared, "We meet in an hour of change and challenge, in a decade of hope and fear, in an age of both knowledge and ignorance . . . We choose to go the moon in this decade and do the other things, not because they are easy but because they are hard . . . because that challenge is one . . . we are unwilling to postpone, and one which we intend to win." Within a few years, America's scientists and engineers had risen to meet that challenge, and our nation won the race to the moon.

Kennedy's victory was part of a great American tradition of expanding the frontiers of innovation. More than a hundred and fifty years before Kennedy put a man on the moon, President Thomas Jefferson worked to put a man out West. At his behest, Lewis and Clark set out on a voyage of discovery—a mission planned out on the tables of the East Room in the White House. There, Jefferson and Lewis

charted the journey that would not only map the contours of our continent, but expand forever the frontiers of our national imagination. They were the forbearers of those who have given us the Mars expedition, an international space station, and a map of the human genome.

From the great frontier to the new frontier, all these discoveries have had a common dominator: the drive, determination and dollars of the federal government. Without Jefferson's encouragement and Kennedy's imagination, America would be a lesser nation. For generations, our leaders have recognized that without government funding for scientific and technological advancement, America would never be a global pioneer in the labs and classrooms—and certainly not a world leader in health care, education, the environment, transportation, finance or national security.

Many of the products and services we have come to depend on—from lasers to communication satellites to human insulin—are the direct result of policies designed to bolster science and technological advancement. Government dollars used for polio eradication, AIDS treatment, and the mapping of the human genome have helped Americans live longer, healthier lives. In the last century alone, the average life expectancy in the United States has increased by nearly 30 years—from 47 to 76.

In national security, federal dollars helped build the atomic bomb, stealth aircraft, and unmanned surveillance drones. In environmental science, thanks to federal investment, manufacturing processes that emit zero waste and fuel-cell cars that get the equivalent 80 miles per gallon are well within our reach. These advances have fueled our remarkable economic prosperity; since World War II, innovation has been responsible for nearly half of our national economic growth.

While it is clear government funding has been critical for the advancement of science, there is considerable debate as to how government funds for scientific research should be allocated.

President Clinton, from the first days of his campaign, viewed science—including biotechnology, information technology and physical sciences—as a core element of his economic policy. I served in an administration that believed that federal investment in technology and human capital would be the driving force behind an economic renewal. Vice-President Al Gore, who has been one of Congress's foremost experts in science policy, strengthened the Clinton Administration's and especially the White House's involvement in science policy.

Before commenting on the Bush Administration's budget, it is worth noting five features of the Clinton-Gore approach to science policy.

First, the Administration brought development of science policy firmly under the grip of the White House. President Clinton established the National Science and Technology Council (E.O. 12281, November 1993), the first cabinet-level council charged with oversight of the federal investment in science and technology. The Council along with the OSTP/OMB annual interagency R&D budget guidance, which established interagency R&D priorities for each fiscal year, reinforced the decision to invest in science and technology even as other spending was cut to eliminate the budget deficit. The President increased R&D spending in each of his eight years in office and ended his second term with a request for $85 billion dollars in R&D spending.

Second, recognizing the demand for greater accountability of scientific research to public officials and private citizens, Clinton took several steps to strengthen oversight of science policymaking. In 1993, he established the President's Committee of Advisors on Science and Technology (E.O. 12882), an advisory board comprised of individuals from industry, education, research institutions, and other nongovernmental organizations. In 1995, the President established the National Bioethics Advisory Commission (E.O. 12975) to ensure the ethical conduct of human biological and behavioral research and to help the Administration address policy issues pertaining to cloning and stem cell research.

Third, the President sought to connect government-funded research to broad, definable national goals. Examples include the *Next Generation Internet* initiative, a project designed to invest in R&D for new networking technologies at speeds that are 1,000 times faster than the then existing Internet; the *Information Technology for the Twenty-First Century (IT²) Initiative*, a multi-agency initiative focused on fundamental research in software, development of information systems that ensure privacy and security of data; the *National Nanotechnology Initiative* to accelerate development and deployment of nanotechnology in areas such as materials and manufacturing, nanoelectronics, medicine and healthcare, environment, energy, chemicals, biotechnology, agriculture, information technology, and national security; a *National Plant Genome Initiative* (NPGI) that supports the sequencing of the genomes of model organisms, including *Arabidopsis thaliana* and an international effort to fully sequence the rice genome; and of course the *Human Genome Project*.

Fourth, the Clinton Administration understood that an increasing share of the nation's R&D budget was coming from the private sector. The Administration sought to harness this private investment for public ends by establishing a series of public-private partnerships, formalizing coordination between corporations, universities and government. Examples included *Partnership for a New Generation of Vehicles* (PNGV), to produce the technology for lighter, more fuel-efficient vehicles and the *Partnership Advancing Technology in Housing*, to spur the development and use of advanced technologies to radically improve the quality, energy efficiency, environmental performance and affordability of the nation's housing. The Clinton Administration also took steps to encourage direct private investment in research and development through patent reform, and R&D tax credit, and programs to bridge the digital divide.

Finally, President Clinton recognized the critical importance of investment in the education of tomorrow's scientists. He significantly increased the funding for science and engineering programs and research at America's universities; the Department of Education and the Department of Defense, for example, earmarked millions for university research. Educating students is directly related to his larger objective of improving the basic scientific literacy of all citizens.

The Bush Administration has built on the Clinton Administration's strong support for Federal R&D. Their FY 2003 Budget proposes an increase for Federal R&D of almost 9 percent or $8.9 billion over FY 2002 levels, bringing R&D funding to a record $112 billion. Notably, the rate of increase for R&D would significantly exceed the overall 6.8 percent increase proposed for overall discretionary spending. Increases would be targeted to defense, the war on terrorism and health and the commitment made by the Clinton Administration and the Congress to double NIH funding between 1998 and 2003 would be completed.

President Bush also continued the President's Committee of Advisors on Science and Technology, albeit with a heavier focus on industry participants rather than leading University-based scientists, and reconstituted the National Bioethics Advisory Commission. His budget continues research initiatives on Nanotechnology and Networking, and Information Technology, and added a new initiative on Anti-terrorism R&D.

The proposed funding increases for the FY 2003 budget for the DOD and NIH are laudable, especially in light of the transformative events of the past year. Those additional funds will aid the development of new technologies to fight the war on terrorism, help fend off future biological attacks and accelerate the process of discovering new treatments for cancer, AIDS and other illnesses.

Nevertheless, the research and development funding in the FY 2003 budget falls short of its potential. While the overall research and development budget has increased, these funds are directed almost exclusively into the NIH and the DOD. Excluding the NIH, non-defense research and development spending is reduced by 0.2%, with many critical programs facing far deeper cuts. By failing to provide adequate funding across scientific disciplines, the budget threatens many key priorities.

Double the NSF Budget

First, the budget fails to adequately support the NSF and threatens the quality basic research conducted at colleges and universities. Discounting the funds allocated as the result of transferring three programs to the NSF from other agencies, the NSF budget is increased a mere 3.4%, barely keeping pace with inflation. The NSF is a model government agency. It performs its job funding university research and other educational programs with unrivaled efficiency. It is the only government agency to receive a "green light" in financial management from the GAO and the OMB. All other government agencies received either a yellow or red light. Moreover, the NSF is the only federal agency with responsibility for research and education in all major scientific disciplines. The basic research conducted with NSF funds is the foundation for all future R&D. A strong commitment to the NSF is essential to a broad-based commitment to research and development.

The NSF's support for the science and technology research across all disciplines is crucial as the science becomes more complex and inter-related. For example, advances in medical care responsible for increasing American's life span could not have occurred without the underlying knowledge in the physical sciences. Magnetic resonance imaging, ultrasound, laser surgery, and artificial joints and valves, which today we take for granted, were only developed with support from physicist, chemists, mathematicians, computer scientists, and engineers. Also, it is impossible to predict where the next scientific discovery that will drive our Nation's economic growth or protect our national security will occur. For example, today's discoveries in the field of nanotechnology are being used in the automotive, apparel, and cosmetic industries in ways those industries could never have foreseen just a few years

ago. Finally, we need to be concerned about training the right mix of scientists and engineers, and other scholars to meet our economic and national security needs of the next generation.

The NSF has an extraordinary impact on American scientific discovery. Eight of the last 12 American Nobel Prize winners were supported by the NSF at some point in their careers. The NSF also plays a crucial role in supporting university-based research, funding roughly 50 percent of all non-medical basic research at colleges and universities. The discoveries from these labs benefit us today and the scientists trained in them will benefit us into the future. I believe doubling the NSF's budget will strengthen our Nation's economy and security by providing support for advancements in science and technology research across all disciplines.

A Manhattan Project for Energy Security

Second, the budget fails to address the nation's needs in creating energy security. Our dependence on fossil fuels is not only a serious environmental problem but also a critical national security problem.

Today we are importing 52% of our oil, 25% from the Persian Gulf, 16% from the Saudi Arabia alone. Imports are projected to rise to 64% by 2020. That figure would only be reduced to 62% if we did everything contained in the President's energy plan or the recently passed Senate Energy bill. Europe and Japan are even more dependent on Middle East oil. China is the fastest growing importer, which is important, if for no other reason than the proliferation problems that will be presented if China becomes dependent on oil from Iran and Iraq.

Less well appreciated are the real national security concerns that will result from global warming pollution. The question is no longer will the atmosphere warm but by how much. Even at the lowest end of climate models that assume rapid cuts in emissions, scientists predict at least a 2.5 degree Fahrenheit increase in global temperature over the next century. Contrast that with the less than 1-degree increase over the last millennium, and you can begin to appreciate the scope of the problem. It is a problem that threatens the security of the world's fresh water supplies and the production of agricultural products around the world. It is a problem that could create an astronomical number of environmental refugees from the Middle East to Bangladesh and Indonesia to Central America. Despite these dangers, this Congress and this Administration do not seem likely to act forcefully to mandate reductions in CO2 emissions. Research and Development seems to be the one area where there is a possibility that Congress and the Administration could agree to take precautionary action to stave off the effects of global warming. The scope of the problem calls for an effort on the scale of the Manhattan Project—massive investments for research and development in new technologies that could reduce CO2 emissions.

Unfortunately, such funding is not present in the FY 2003 budget. The FY 2003 budget decreases funding for energy conservation by 10.9%. These programs have proven to be an extraordinarily effective way to reduce our energy consumption and, as a corollary, our dependence on foreign oil. A DOE study found that twenty of its energy efficiency and renewable energy technologies have already saved the nation 5.5 quadrillion BTUs of energy over the last two decades, the equivalent to the amount of energy needed to heat every household in the U.S. for about a year. The cost to taxpayers for these 20 activities was $712 million, less than 3 percent of the energy bill savings to date.

Funding for renewable energy, while nominally increased over the previous year, has been shifted into the FreedomCar initiative, a laudable research program, but one that will take many years to yield results. Meanwhile, funding for the New Generation Vehicle program, which could enhance fuel efficiency immediately, has been eliminated. While wind-power research receives a small increase, research for biomass, geothermal and solar energy are all reduced by two to three percent. A budget with a broad based research commitment to energy conservation and alternative fuels would support a cleaner, healthier and more secure nation.

Resist the Temptation to Earmark Research and Development Funding

The Bush Administration has launched a major effort to reduce the amount of research and development funding that is earmarked to specific institutions. While that effort may not be popular on Capitol Hill, I want to go on record in support of the Bush Administration's position in this area. Research and development funding should be allocated through the peer-review system, which awards grants competitively. Earmarking funds politicizes scientific research and development. It creates an opportunity for institutions to be funded, outside the competitive process, not for the scientific merit of their proposals but for their connections to influential members of Congress. There are already many promising peer-reviewed proposals that are unable to be funded due to limited resources. Earmarking only creates further reductions in the amount of funding available for such higher-priority projects.

As budgets tighten, the temptation for Congress to earmark funds increases. Congress does have the right and responsibility to set priorities for Science agencies. But in order to ensure our nations receives the maxim benefit from federal research dollars, Congress should resist the temptation to earmark funding for specific projects.

The NSF has traditionally been a safe haven from Congressional earmarking. It is essential that this remain the case. Universities and colleges should be focusing their energy on creating better research not lobbying the Congress for funds. Funding should be given to those institutions with the best proposals not the best connections.

Restore the Congressional Office of Technology Assessment

As the pendulum shifts away from a system that emphasizes research that explores scientific possibilities to one focused on near term R&D needs (from cybersecurity to national missile defense, to new surveillance technologies, to vaccine research), we still don't have adequate metrics or oversight mechanisms that measure outcomes.

We are good at measuring inputs (dollars requested, dollars appropriated to specific federal R&D accounts, doubling NIH funds); for the most part, we successfully measure outputs (DOD-ARPA/supported research that helped invent the Internet) and only rarely reflect on outcomes (11,000 additional cancer deaths per year as a result of above ground nuclear testing in the1950's and early 1960's).

While many individuals, institutions and agencies have an interest in touting individual success stories, no body or oversight institution has a vested interest in reviewing and reporting to the public on the overall trends in public scientific investment, the rates of return in public goods, the costs to the public from increased regulatory activity or from cleaning up spectacular failures.

The closest that the federal government ever came to institutionalizing an oversight mechanism useful to federal decision makers was the Congressional Office of Technology Assessment. That office conducted important, comprehensive studies on complicated issues years before they came to the national forefront. It was widely admired around the globe. Indeed Britain, France, Denmark, the Netherlands, the EU, the OECD and the UN have created agencies modeled after the OTA. Unfortunately, the OTA fell victim to the budget-cutting ax in 1995. It is important that Congress have access to objective analysis of competing points of view on important scientific questions and research opportunities. Re-creation of the OTA, run, as in the past, by a strong bipartisan board would be a giant step in the right direction.

Support Scientific Freedom and Openness

Not since our earliest days of the Cold War have we been faced with the question of the balance between scientific freedom and openness and the needs of national security and public safety. We are confronted today with an enemy that operates in the shadows, that will not only tolerate but target civilian casualties and has, at least, expressed an interest in acquiring the know-how to obtain weapons of mass destruction.

How then, does the scientific community react to this new threat?

It is clear that the Bush Administration has a strong policy preference for tilting the balance in favor of secrecy; for withholding government generated information that may in any way pose a threat if used by our adversaries; for encouraging public institutions and quasi-public institutions, including universities to self-sensor; to remove publicly useful information from government web sites; to carry out research through the Department of Defense and Energy's black programs; to keep foreign students from studying "sensitive" academic subjects; to provide original classification authority to the Department of Health and Human Services, which will complicate the flow of public health information between the federal government and State and local authorities. In sum, we are well on our way to re-establishing the culture of secrecy across many sciences and disciplines, including biology, which was characteristic of the cold war approach to nuclear weapons, satellite imagery and cryptographic research.

At a very minimum, a trend which took root under Vice President Gore's leadership during the Clinton Administration to make scientifically valuable, but formerly classified data publicly available has come to a halt. For example, in 1995, for the first time, the overhead imageries from the Corona, Argon and Lanyard intelligence satellite missions were declassified—historic documents that will be of great value to scholars, as well as to the natural resource and environmental communities. Today the Department of Defense is buying up all commercial satellite imagery and older overhead imagery is being withheld from the public.

In 1998, undersea military data originally gathered to track enemy submarines was declassified and released to help researchers track marine mammals, predict deadly storms, detect illegal fishing, and gain new insights in to the complexities of climate change. The fate of that program is also in doubt.

This new culture of secrecy is bound to influence the direction of discovery, the efficient advancement of scientific knowledge, and the public's, or at least their representatives in Congress', opportunity to assess the costs that come from a science program unchecked by public scrutiny. Before we rush headlong into this new era of scientific secrecy, we should pause to remember the nuclear-exposure experiments carried out in this country on human subjects, including the mentally retarded and even children, and remember also, that the Ames strain of anthrax that was used in the attacks last fall was probably developed in a classified military program, ostensibly for defensive purposes.

Public knowledge, public scrutiny with free exchange of scientific information may not only provide the basis to make the breakthroughs necessary to stay ahead of our adversaries, but may provide a better long-term security paradigm as well. As National Academy of Sciences President Bruce Alberts recently noted, "Some of the planning being proposed (on restrictions of scientific publication) could severely hamper the U.S. research enterprise and decrease national security."

While we must always be mindful of the fact that there are secrets worth protecting, only strong Congressional support for scientific freedom with a vigorous program of Congressional oversight will keep us from slipping back into a culture of secrecy which will not only slow the advancement of science in general, but will also hobble our ability to develop new technologies to secure our nation.

Conclusion

There is much in the 2003 R&D budget that can be commended. Overall spending increases, continuing the Clinton administration's strong support of the scientific research. There is strong support for the health sciences and national security, which are unquestionably high-priority areas. Nevertheless, there is room for improvement. Adequate funding should be provided over a broader range of scientific disciplines. The NSF should be more strongly supported. Increased funding should be provided to create energy security and reduce global warming. Further, the government should assess technological outcomes and, as much as possible, make those outcomes public. These suggestions would allow federal monies to more fully harness the efforts and ingenuity of the scientific community for the common good.

Senator WYDEN. Well, thank you for an excellent presentation. What was striking is that when the Speaker was talking, you nodded quite a bit. And when you were talking, he nodded quite a bit. I think particularly in areas like environmental and energy research, you can have a debate about whether, after that research, you should go this route or that route with respect to a regulatory policy or a tax policy or something of that nature. But to have the fundamental research in the environment and energy area at a time when those questions impact our national security is critical. So both of you have just given very, very helpful presentations, and we'll have some questions in a moment.

Let's go next to Dr. Leshner. And we know of the Association's long involvement in these issues. And you proceed, please.

STATEMENT OF ALAN I. LESHNER, PH.D., CHIEF EXECUTIVE OFFICER, AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Dr. LESHNER. Good, thank you very much, Chairman Wyden, Senator Allen. I'm delighted to be here.

I represent the largest general scientific society in the world with over 130,000 members and 275 affiliated societies. Our members come from the entire range of science, engineering, and technology disciplines.

From that unique perspective, I can tell you that our nation's science and technology enterprise is experiencing yet another won-

derfully successful year with an array of exciting opportunities that will yield important benefits throughout society. A critical point is that many of this year's most important findings illustrate the principle we've been talking a bit about, that advances in any one field are dependent on an interwoven set of processes that require simultaneous progress throughout the broad science and technology enterprise. And I'd like to just give you a couple of examples.

The first is one we've been talking about, which was Science Magazine's breakthrough of the year, nanotechnology. These breakthroughs depend heavily on fundamental discoveries simultaneously in condensed matter physics, chemistry, and material science.

The second example comes from the intersection of astronomy and medicine. Advanced optics developed for astronomical telescopes are now being used to map the eye retina and may lead to improved optimal surgery and corrective lenses.

One more, molecular biologists and material scientists have collaborated and produced incredibly strong spider silk from mammalian cells, another advance in material science that could have tremendous implications.

And, finally, having just come to AAAS from NIH, I want to emphasize that progress in all of the biomedical sciences is heavily dependent on the health of the entire array of science and engineering fields. You know, of course, about the application of fiberoptics in medical scoping in the use of lasers in surgery.

In my own area of highest expertise, the brain mechanisms of addiction, advances in physics and their applications in medical imaging technology have finally allowed us to look into the brains of living, awake humans during and following drug experiences. These studies, based on physics, have revolutionized our understanding of this great social and health problem.

So my testimony today on the Administration's budget request reflects our belief that balanced and strong support across the entire science and technology enterprise is critical to the nation's future. Having said that, the Administration's request for total federal R&D is a record $112 billion. That's $8.9 billion more than the total for fiscal 2002. And, of course, we applaud this strong commitment to science, as have many of my other colleagues.

However, the proposed increases for DOD and NIH make up the entire amount, leaving the remaining R&D agencies with level funding or less. Non-defense R&D would increase 7.2 percent, for a total of $53.3 billion. Yet when increases to the NIH are excluded, non-defense R&D would actually fall by 0.2 percent.

With respect to agencies under this Subcommittee's jurisdiction, as we've discussed, the total NSF budget would be $5 billion, a five percent increase over fiscal 2002. NSF's R&D line would increase $125 million, for a total of $3.7 billion. However, more than half of that R&D increase is due to the proposed transfer to NSF of three programs that come from other agencies, accounting for $76 million of the $125 million increase. So without these transfers, NSF R&D would increase only by 1.4 percent, which is well below the rate of inflation.

Just touching on NASA, its total budget would increase only slightly to $15.1 billion. Intramural R&D at the National Institute

of Science and Technology, at NIST, would receive a $70 million increase, for $402 million, including funding the complete the new Advanced Measurement Laboratory.

If we take a step back and look at trends in federal research by discipline between fiscal years 1970 and 2000, we can see that federal support for the life sciences has grown dramatically, from more than $5 billion constant dollars in fiscal 1970 to over $20 billion in fiscal 2001. On the other hand, most math, science, and engineering disciplines have shown relatively flat or, at most, modest growth. The Administration has clearly made defense and medical research its highest R&D priorities.

Our view, however, is that the opportunities and the needs go far beyond those two areas. According to Science Magazine's predictions for the coming year, we are poised for significant advances in astronomy with the proposed launch of a new telescope in Chile, more precise global positioning systems through the use of optical clocks, and improved visualization systems that will allow us to examine biological molecules and watch cells signaling as it occurs. These opportunities and the interconnectedness of all sciences emphasize the need to maintain progress simultaneously across all of science and technology.

In the 21st century, science and engineering fields are so interdependent, that lags in one field inevitably will delay progress in others. We cannot afford a taking-turns approach to science funding. Our continued national security and improving quality of life depend on a uniformly health and rapidly growing science and technology enterprise across the board.

Thank you very much.

[The prepared statement of Dr. Leshner follows:]

PREPARED STATEMENT OF ALAN I. LESHNER, PH.D., CHIEF EXECUTIVE OFFICER, AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Introduction

Mr. Chairman, Senator Allen, members of the Subcommittee, thank you for this opportunity to testify before you today on the FY 2003 budget request for research and development (R&D). I represent the largest general scientific society in the world with over 130,000 members and 275 affiliated societies. Our members come from the entire range of science and technology disciplines.

From that unique perspective, I can tell you that our nation's science and technology enterprise continues its great productivity, and has had a tremendously successful year with an array of exciting advances that will yield benefits throughout society. Moreover, many of this past year's most important findings illustrate and emphasize that in the current age, major advances in any one specialty field are dependent on an integrated, interwoven set of processes that requires simultaneous progress throughout the broad science and technology enterprise. A few examples include:

- *Science* magazine's breakthrough of the year: nanotechnology. Scientists and engineers have created the first set of molecular-scale circuits that, when they are wired to computer chip architectures, will provide incredible computing power in tiny machines. This set of breakthroughs depends heavily on fundamental discoveries in condensed matter physics, chemistry, and materials science.
- Geologists and chemists have made tremendous progress in revealing the mechanisms of the breakdown of organic matter that can determine soil fertility and the dispersal of soil contaminants.
- Using animal models, scientists at an NSF-built science and technology center have worked out many of the molecular and neural mechanisms of the body's biological clock, including critical gene elements. Building on this work, clinical

investigators have now shown direct application of these findings in human subjects who have many similar genes.

- Combining molecular biology and materials science, researchers have, basically, produced spider silk fibers from mammalian cells.
- Advanced optics developed for astronomical telescopes are now being used to help map the eye retina and may lead to improved optical surgery and corrective lenses.

Since I came to AAAS recently from the National Institute on Drug Abuse at NIH, I also want to emphasize that progress in all of the biomedical sciences is heavily dependent on the health of the entire array of scientific fields. You know, of course, about the application of fiber optics in medical scoping, and the use of lasers, developed by physicists and chemists, in surgery. In my own area of highest expertise—the brain mechanisms of addiction—advances in physics and their applications in imaging technology are directly responsible for our finally being able to look into the brains of living, awake humans during and following drug experiences, and those studies have revolutionized our understanding of this great social and health problem.

Over twenty federal agencies contribute to federal R&D, many of them under your subcommittee's jurisdiction. Each agency, according to its mission, plays a very important role in contributing to our nation's R&D productivity, and it is important that all agency science programs receive strong support. It is also important to note, however, that NSF has a specific mission to pursue basic research across the full-range of science and technology disciplines and therefore plays a very special and unique role.

Research and Development in the FY 2003 Budget Request

My testimony today is intended to examine R&D in the Administration's budget request, to highlight trends in federal support for R&D across disciplines, and to discuss university R&D. It reflects our belief that balanced and strong support across the entire science and technology enterprise is critical to the nation's future.

Overall Outlook

The request for total federal R&D in FY 2003 is a record $112 billion, $8.9 billion more than FY 2002 (see Table 1). However, the proposed increases of $5.2 billion for DOD and $3.7 billion for NIH make up the entire $8.9 billion increase, leaving all other R&D funding agencies combined with barely the same amount as in FY 2002.

- Nondefense R&D would increase 7.2 percent to $53.3 billion. NIH would make up almost half of the entire nondefense R&D portfolio, receiving the final installment of a plan to double the NIH budget in five years. Excluding NIH, nondefense R&D would fall by 0.2 percent to $26.8 billion.
- Basic research would increase $1.9 billion to an all-time high of $25.5 billion (see Table 2). For the past two years NIH has supported the majority of federal basic research, and in FY 2003 it would provide 56 percent of all federal support.
- The total federal investment in basic and applied research combined would increase 6.5 percent to $51.9 billion in FY 2003 (see Table 2), with a large increase for NIH (up 14.5 percent to $25.6 billion) responsible for most of the increase. Without NIH, total federal research would decline by 0.2 percent (or $48 million) to $26.3 billion.

R&D in NSF, NASA, NIST, and NOAA

The National Science Foundation (NSF) budget would total $5.0 billion in FY 2003, an increase of 5.0 percent. Excluding NSF's non-R&D education activities, NSF R&D would be $3.7 billion, a boost of 3.5 percent or $125 million. More than half of the increase, however, is due to proposed transfers to NSF—of the National Sea Grant program from the Department of Commerce; hydrologic sciences from the Department of the Interior; and environmental education from the Environmental Protection Agency. These three proposed transfers account for $76 million of the $125 million increase to NSF R&D. I emphasize the term "proposed" because the program transfers must be authorized and appropriated with congressional oversight. Excluding the transfers, NSF R&D would only increase 1.4 percent, less than the rate of inflation.

The National Aeronautics and Space Administration (NASA) would see its total budget increase by 0.7 percent to $15.1 billion in FY 2003. NASA's R&D (two-thirds of the agency's budget) would climb 4.3 percent to $10.7 billion. While the much-

delayed International Space Station would receive $1.5 billion for construction, down from $1.7 billion, most science programs would receive increases.

While last year's budget would have eliminated the Advanced Technology Program (ATP) at the National Institute of Standards and Technology (NIST), the FY 2003 budget would keep it alive, though at a greatly reduced level. NIST would instead redirect funds to intramural R&D in the NIST laboratories, which would receive a $70 million increase to $402 million, including funding to make the new Advanced Measurement Laboratory operational.

National Oceanic and Atmospheric Administration (NOAA) R&D would decline by 1.1 percent or $6 million because of the transfer of the $62 million (in FY 2002) National Sea Grant program from NOAA to NSF. Overall, other NOAA R&D programs would see increases.

Multi-agency Initiatives

Three major multi-agency initiatives that would receive increases in the FY 2003 budget merit special mention.

- Funding for the Nanoscale Science, Engineering, and Technology Initiative would climb another $106 million (or 17.5 percent) to $710 million in FY 2003. NSF's lead contribution to the initiative would rise by 11.1 percent to $221 million.
- NSF also continues its lead role in the Networking and Information Technology R&D initiative, which would see its budget edge up 2.5 percent to $1.9 billion.
- The longstanding U.S. Global Change Research Program would climb 2.6 percent to $1.7 billion. While NASA's Earth Science program continues to provide the bulk of funding ($1.1 billion), the increases in FY 2003 would go mostly to other agencies' contributions. There would also be $40 million in new funds for the Climate Change Research Initiative (CCRI) for fundamental research to fill key gaps in climate science knowledge.

R&D in Colleges and Universities

Despite their comparatively small share of overall federal R&D funding, colleges and universities serve as the primary site for the performance of basic research and the training of future scientists and engineers. On average, 58 percent of the R&D performed by colleges and universities is funded by the federal government, with most of the rest coming from the institutions' own funds (see Chart 1).

Trends in the R&D Portfolio

AAAS also analyzes the budget across all agencies, and that helps to understand trends characterizing the science and technology enterprise as a whole.

- Looking at trends in federal research by discipline between FY 1970–2000, one can see that engineering, physical sciences, environmental sciences, mathematics and computer sciences, social sciences, and psychology are relatively flat, or in some instances, show modest growth. At the same time, federal support for the life sciences has grown dramatically, from slightly more than $5 billion in FY 1970 (using constant dollars) to over $20 billion in FY 2001. (see Chart 2)
- Analyzing federal support for life sciences, physical sciences, and engineering research by agency, one can see how dependent the life sciences are on funding from NIH. In contrast, most fields of physical science and engineering research are dependent on funds from many different agencies (see Charts 3 and 4).

Conclusion

The FY 2003 budget now moves to Congress, which must take on the task of establishing budget priorities. This task occurs in a Congress far different from last year, with some members criticizing the budget for too little funding on domestic programs, and others espousing that it spends too much.

For R&D, the Administration has clearly placed greater priority upon defense and medical research. The opportunities for R&D, however, are much more extensive. According to *Science* magazine's predictions for 2002, we should see significant advances in astronomy with the proposed launch of a second large telescope in Chile; more precise global positioning systems through the use of optical clocks that rely on visible light waves; and greater clarity of visualization systems through improved imaging technology and faster computers that will allow us to examine biological molecules and watch cell signaling as it occurs. These and other scientific opportunities face Congress as it prepares to decide how to allocate precious R&D resources.

Let me conclude by emphasizing again the need to maintain progress simultaneously across all of science and technology. In the 21st Century, science and engi-

neering fields are so inter-dependent that lags in one field inevitably will delay progress in others. We cannot afford a "taking-turns" approach to science funding in this country. Our continued national security and improving quality of life depend on a uniformly healthy and rapidly growing science and technology enterprise.

AAAS Analysis of R&D in the FY 2003 Budget

Table 1. R&D in the FY 2003 Budget by Agency
(budget authority in millions of dollars)

	FY 2001 Actual	FY 2002 Estimate	**FY 2003 Budget**	Change FY 02-03 Amount	Change FY 02-03 Percent
Total R&D (Conduct and Facilities)					
Defense (military)	42,740	49,639	**54,827**	5,188	10.5%
S&T (6.1-6.3 + medical)	*9,365*	*10,341*	***9,957***	*-384*	*-3.7%*
All Other DOD R&D	*33,375*	*39,298*	***44,870***	*5,572*	*14.2%*
Health and Human Services	21,045	24,141	**27,551**	3,410	14.1%
Nat'l Institutes of Health	*19,807*	*22,795*	***26,452***	*3,657*	*16.0%*
NASA	9,887	10,232	**10,676**	444	4.3%
Energy	7,733	8,361	**8,323**	-38	-0.5%
NNSA and other defense	*3,462*	*3,839*	***3,947***	*108*	*2.8%*
Energy and Science programs	*4,271*	*4,522*	***4,376***	*-146*	*-3.2%*
Nat'l Science Foundation	3,320	3,526	**3,651**	125	3.5%
Agriculture	2,181	2,334	**2,118**	-216	-9.3%
Commerce	1,030	1,096	**1,100**	4	0.3%
NOAA	*561*	*611*	***605***	*-6*	*-1.1%*
NIST	*413*	*460*	***483***	*23*	*5.0%*
Interior	621	660	**628**	-32	-4.8%
Transportation	718	778	**736**	-42	-5.4%
Environ. Protection Agency	574	592	**627**	35	5.9%
Veterans Affairs	719	761	**810**	49	6.5%
Education	264	268	**311**	43	16.0%
All Other	702	763	**689**	-74	-9.7%
Total R&D	91,534	103,150	**112,047**	8,897	8.6%
Defense R&D	46,202	53,478	**58,774**	5,297	9.9%
Nondefense R&D	45,332	49,672	**53,273**	3,601	7.2%
Nondefense R&D excluding NIH	*25,525*	*26,877*	***26,821***	*-56*	*-0.2%*
Basic Research	21,376	23,635	**25,499**	1,864	7.9%
Applied Research	22,451	25,050	**26,370**	1,320	5.3%
Development	42,959	49,390	**55,235**	5,845	11.8%
R&D Facilities and Equipment	4,749	5,075	**4,943**	-132	-2.6%

Source: AAAS, based on OMB data for R&D for FY 2003, agency budget justifications, and information from agency budget offices.
All years include homeland security and other emergency appropriations.
All years adjusted to include proposals to fully fund federal retiree costs.
March 5, 2002 - REVISED

AAAS Analysis of R&D in the FY 2003 Budget

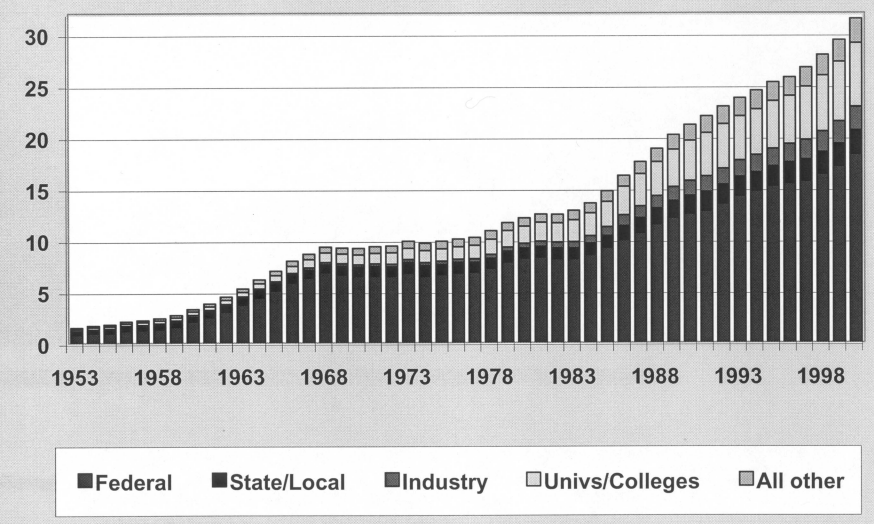
Table 2. Research in the FY 2003 Budget
(budget authority in millions of dollars)

	FY 2001 Actual	FY 2002 Estimate	**FY 2003 Budget**	Change FY 02-03 Amount	Percent
BASIC RESEARCH					
Defense (military)	1,287	1,376	**1,365**	-11	-0.8%
Health and Human Services	11,642	13,193	**14,379**	1,185	9.0%
Nat'l Institutes of Health	*11,639*	*13,190*	***14,376***	*1,185*	*9.0%*
NASA	1,695	1,967	**2,361**	395	20.1%
Energy	2,390	2,424	**2,519**	94	3.9%
Nat'l Science Foundation	2,852	3,058	**3,205**	147	4.8%
Agriculture	801	860	**880**	20	2.3%
Commerce (NIST)	50	52	**73**	21	40.4%
Interior	56	58	**55**	-3	-4.4%
Transportation	17	13	**25**	12	92.6%
Environ. Protection Agency	104	107	**101**	-6	-5.3%
Smithsonian	108	111	**114**	3	2.7%
Veterans Affairs	289	329	**351**	23	6.9%
All Other	84	87	**70**	-17	-19.5%
Total Basic Research	21,376	23,635	**25,499**	1,864	7.9%
Basic research excluding NIH	*9,737*	*10,445*	***11,123***	*679*	*6.5%*
RESEARCH (basic + applied)					
Defense (military; incl. medical)	5,393	5,926	**5,213**	-713	-12.0%
Health and Human Services	20,735	23,610	**26,636**	3,027	12.8%
Nat'l Institutes of Health	*19,561*	*22,346*	***25,578***	*3,232*	*14.5%*
NASA	4,294	4,824	**5,549**	725	15.0%
Energy	4,697	5,155	**5,188**	32	0.6%
Nat'l Science Foundation	3,032	3,250	**3,404**	154	4.7%
Agriculture	1,845	1,846	**1,826**	-20	-1.1%
Commerce	825	887	**883**	-4	-0.4%
NOAA	*511*	*546*	***546***	*0*	*0.0%*
NIST	*306*	*334*	***328***	*-6*	*-1.8%*
Interior	590	628	**596**	-32	-5.1%
Transportation	461	517	**506**	-10	-2.0%
Environ. Protection Agency	474	489	**531**	41	8.5%
Veterans Affairs	704	745	**794**	48	6.5%
Education	174	180	**213**	33	18.3%
Agency for Int'l Develop.	249	268	**182**	-86	-32.1%
Smithsonian	108	111	**114**	3	2.7%
All Other	246	249	**235**	-14	-5.6%
Total Research	43,826	48,685	**51,869**	3,184	6.5%
Total research excluding NIH	*24,265*	*26,339*	***26,291***	*-48*	*-0.2%*

Source: AAAS, based on OMB data for R&D for FY 2003, agency budget justifications, and information from agency budget offices.
All years include homeland security and other emergency appropriations.
All years adjusted to include proposals to fully fund federal retiree costs.
March 5, 2002 - REVISED

Chart 1. R&D at Colleges and Universities by Source of Funds

in billions of constant FY 2002 dollars, FY 1953-2000



Source: National Science Foundation, Survey of Research and Development Expenditures at Universities and Colleges, Fiscal Year 2000, 2001. Constant-dollar conversions based on OMB's GDP deflators.

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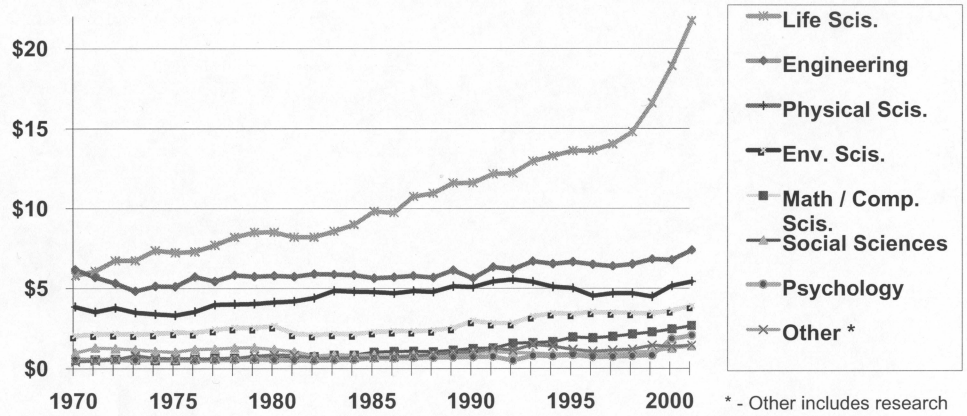
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Chart 2. Trends in Federal Research by Discipline, FY 1970-2001

obligations in billions of constant FY 2002 dollars



* - Other includes research not classified (includes basic research and applied research; excludes development and R&D facilities)

Source: National Science Foundation, *Federal Funds for Research and Development FY 2000, 2001, and 2002,* 2002. FY 2001 data are preliminary. Constant-dollar conversions based on OMB's GDP deflators.

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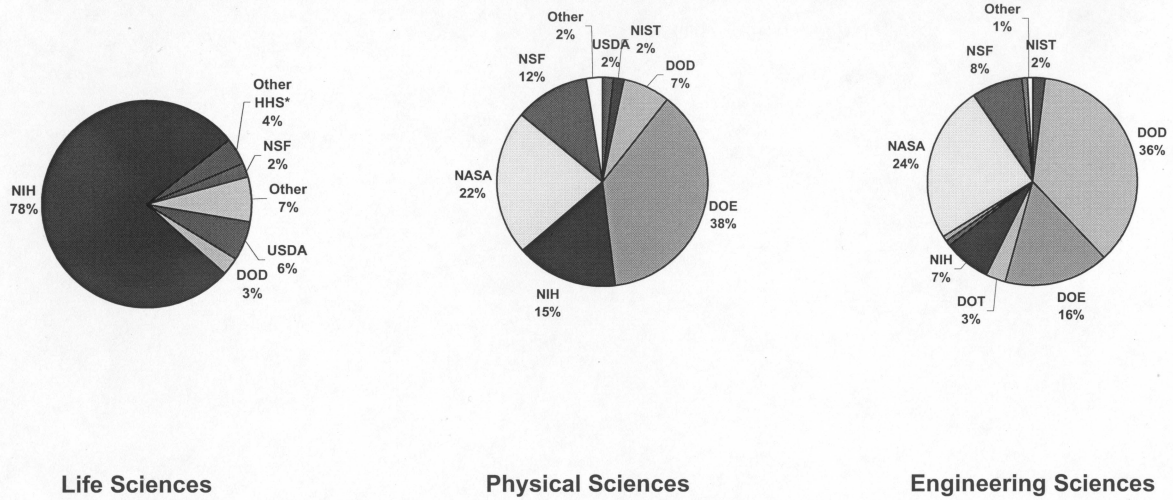
Chart 3. Federal Funding of Research By Agency and Discipline, FY 2002
(preliminary obligations)



Source: National Science Foundation, *Federal Funds for Research and Development FY 2000, 2001, and 2002,* 2002. Data exclude engineering work classified as development and R&D facilities

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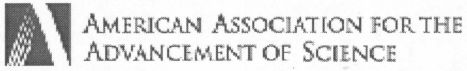
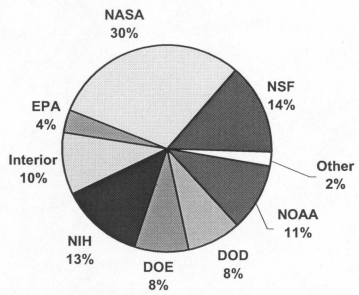
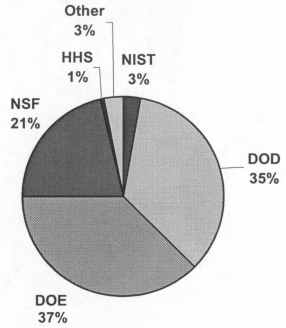


Chart 4. Federal Funding of Research By Agency and Discipline, FY 2002

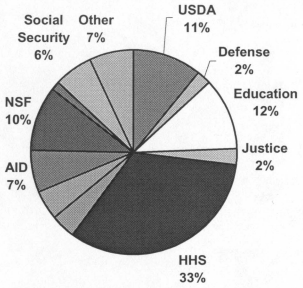
(preliminary obligations)



Environmental Sciences



Computer Sciences*



Social Sciences

Source: National Science Foundation, *Federal Funds for Research and Development FY 2000, 2001, and 2002,* 2002. Data exclude engineering work classified as development and R&D facilities. * - FY 2000 data.

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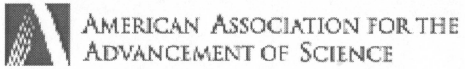

APPENDIX

American Association for the Advancement of Science (AAAS)

Founded 150 years ago, AAAS is the world's largest federation of scientific and engineering societies, with nearly 275 affiliates. AAAS counts more than 130,000 individual scientists, engineers, science educators, policymakers, and interested citizens among its members, making it the largest general scientific organization in the world. Our mission is to advance science and innovation throughout the world for the benefit of all people. Our objectives in this mission are to foster communication among scientists, engineers and the public; enhance international cooperation in science and its applications; promote the responsible conduct and use of science and technology; foster education in science and technology for everyone; enhance the science and technology workforce and infrastructure; increase public understanding and appreciation of science and technology; and strengthen support for the science and technology enterprise.

Every year since 1976, AAAS has published an annual report analyzing research and development (R&D) in the proposed federal budget in order to make available to the scientific and engineering communities and to policymakers timely and objective information about the Administration's plans for the coming fiscal year. At the end of each congressional session, AAAS also publishes a report reviewing the impact of appropriations decisions on research and development. AAAS has also established a Web site for R&D data on which we now post regular updates on budget proposals, agency appropriations, and outyear projections for R&D, as well as numerous tables and charts. The address for the site is www.aaas.org/spp/R&D.

Alan I. Leshner

Dr. Leshner became Chief Executive Officer of the American Association for the Advancement of Science and Publisher of *Science* Magazine in December 2001.

Prior to coming to AAAS, Dr. Leshner was Director of the National Institute on Drug Abuse (NIDA). One of the scientific institutes of the U.S. National Institutes of Health, NIDA supports over 85% of the world's research on the health aspects of drug abuse and addiction. Prior to becoming Director of NIDA, Dr. Leshner had been the Deputy Director and Acting Director of the National Institute of Mental Health. He went to NIMH from the National Science Foundation (NSF), where he held a variety of senior positions, focusing on basic research in the biological, behavioral and social sciences, and on science education.

Dr. Leshner went to NSF after 10 years at Bucknell University, where he was Professor of Psychology. While on the faculty at Bucknell, he also held long-term appointments at the Postgraduate Medical School in Budapest, Hungary; at the Wisconsin Regional Primate Research Center; and as a Fulbright Scholar at the Weizmann Institute of Science in Israel. Dr. Leshner's research has focused on the biological bases of behavior. He is the author of a major textbook on the relationship between hormones and behavior, and numerous book chapters and papers in professional journals. He also has published extensively in the areas of science and technology policy and education.

Dr. Leshner received his undergraduate degree in psychology from Franklin and Marshall College, and M.S. and Ph.D. degrees in physiological psychology from Rutgers University. He also holds honorary Doctor of Science degrees from Franklin and Marshall College and the Pavlov Medical University in St. Petersburg, Russia. He has been elected a fellow of many professional societies, is a member of the Institute of Medicine of the National Academy of Sciences, and has received numerous awards from both professional and lay groups.

Senator WYDEN. Well said. And it's interesting this point you make with respect to the interdependence of research. To some extent, the research field is a little bit like an ecosystem—what you do over here can have dramatic ramifications over there. And very well said.

Let's go now to Thomas McCoy of Montana State.

STATEMENT OF TOM MCCOY, VICE PRESIDENT OF RESEARCH, MONTANA STATE UNIVERSITY

Mr. MCCOY. Senator Wyden and Allen, thank you for inviting me to this hearing today. I'm Tom McCoy, vice president for research at Montana State University in Bozeman, Montana. I'm also vice

chair of the EPSCoR Coalition, the specific program that I'd like to address today in my—at this hearing.

EPSCoR is a program for 21 states. It's an experimental program to stimulate competitive research. It includes 21 states, as well as Puerto Rico. It's important to note that these 21 states plus Puerto Rico collectively receive less than ten percent of all NSF funding and all federal R&D funding.

Montana State University serves a student body of approximately 11,000 students, most of whom come from Montana. It's a land-grant institution in the state, and, as such, has strong and proven programs in agriculture and natural resources.

During the last decade, Montana State University has experienced exponential growth in its research program. Since 1990, our external grants and contracts have increase over 400 percent, from $17 million in 1990 to about $70 million this past year, and that's on the basis of expenditures.

MSU's research program is also noteworthy. We were awarded one of the earliest NSF engineering research centers in the area of bio-films, and we have a strong recognized program in this area. We also have developed a strong program in optoelectronics in which our faculty are engaged in cutting-edge research. And we also provide laboratory facilities and support for many of the optoelectronic companies that have been created in the Bozeman area.

We have established one of the very early programs in thermal biology, building both on the expertise of our faculty and our location near the thermal pools and soils in Yellowstone National Park. Our researchers are widely published and highly competitive.

It's important to note that we have a student body that's also been very successful. MSU ranks among the top schools in the country for the number of students that receive the nationally prestigious Goldwater Scholarships for undergraduate excellence in mathematics and science. The three 2002 awards that we received bring the total to 40, which makes us number—sixth in terms of total awards, placing us with Harvard and Cal Tech in the top ten.

In addition, two Montana State University seniors were named to the 13th annual All–USA College Academic Teams this year, bringing to 17 the number of MSU students selected since this program began in 1989. We also had a student who won the Alice T. Schafer Prize for the nation's best female mathematics student this past year.

Most of our students attribute their successes to participating in research projects at MSU. Cutting-edge research opportunities are available to our students at all levels through a program that we have called the Undergraduate Scholars Program. And it's important to note that a major part of this program is funded with EPSCoR funds.

In addition to awards for individual students, our faculty also generated a Center for Learning and Teaching Award as well as an IGERT Award awarded by the National Science Foundation.

I'm proud of our achievements at Montana State University. But despite our successes, I'm acutely aware that we will continue to need substantial federal research funding, and, in particular, EPSCoR funding in computing and networking support from NSF.

A major obstacle for many of the EPSCoR state institutions has always been the lack of infrastructure. NSF recently implemented a new EPSCoR Research Infrastructure Improvement Program. It will, for the first time in the EPSCoR program's history give us a credible investment over a period of time that will allow us to develop the clusters and centers that are necessary if we are to be truly competitive. most important request of you today is that this program be fully funded, and let it fully operate over the next several years.

I would also like to make a plea for continued support for advanced computing and networking in our states. Most of the EPSCoR states are either rural and sparsely populated or serve large numbers of under-represented groups, two categories where connections in advanced computing capabilities tend to be most lacking. Our rural areas are where these services tend to be the most expensive. The digital divide, as you all know, is largely about money.

Research facilities and instrumentation also continue to be a major challenge for institutions such as Montana State. Increasingly, our researchers need state-of-the-art laboratories and facilities if we are to pursue latest research opportunities and take advantages of major increases in NIH and NSF funding.

And, finally, I would like to comment on participation or inclusion. For many years, researchers from EPSCoR states were seldom found on review panels or advisory committees. Some efforts have been underway at NSF to rectify this lack of representation, and, in some programs, we have seen real progress. In others, we still have a long way to go. Serving on such panels is vital to integrating our researchers into the overall research community.

Several years ago, the President's Information Technology Advisory Committee, PITAC, was formed, initially, without a single member from EPSCoR state. And again, this is 21 states in this country. Thanks to this Committee, and I mean this particular Committee, especially to Senator Burns, Lott, Hollings, and Rockefeller, and to support at NSF, we were able to have two appointments made from EPSCoR states. We currently have no one from an EPSCoR state on the PCAST and only two members from EPSCoR states on the National Science Board.

In a recent discussion, someone asked me what the EPSCoR states really want. We want a truly national and international research community. We believe that almost half of the states in this country should be sharing a bit more than ten percent of all federal R&D. We want a vibrant and widely dispersed networking and advanced computing infrastructure, and we need help with facilities and equipment. We also need increased representation on major boards and panels, and we need a strong and fully funded EPSCoR program to do this, and we need your continued support for that.

Legislation as we're talking about today, has been introduced in the House to move toward doubling the NSF budget. I'm very pleased to hear Speaker Gingrich say he would like that to be tripled, at least. The Coalition of EPSCoR States strongly supports any increase in the NSF budget. I believe, however, that any doubling should have focus. There must be priorities and a road map for where we're going. And EPSCoR should be part of that road

map to assist the 21 states and Puerto Rico that participate in the program.

We also support legislation to expand networking and advanced computing programs at NSF, again making a special effort to see that this infrastructure is widely dispersed.

We appreciate the work of this Committee and look forward to working with you in the future. And thanks for giving me the opportunity to testify.

[The prepared statement of Mr. McCoy follows:]

PREPARED STATEMENT OF TOM MCCOY, VICE PRESIDENT OF RESEARCH, MONTANA STATE UNIVERSITY

I am Tom McCoy, Vice President for Research, Creative Activities and Technology Transfer at Montana State University (MSU) in Bozeman, Montana. I am also Vice Chair of the EPSCoR Coalition, an organization of some 21 states and Puerto Rico that participate in the National Science Foundation's Experimental Program to Stimulate Competitive Research (EPSCoR) and that have traditionally been viewed as "less research intensive states"—a term that is perhaps increasingly inappropriate, although these states collectively still receive less than 10 percent of all NSF funding and all federal R&D funding.

Montana State University serves a student body of approximately 11,000 students, most of whom come from Montana. It is the land grant institution in the state, and as such has strong and proven programs in agriculture and natural resources. I came to Montana State in 1990 and became Vice President for Research in l998, after serving as a department head from 1990 to 1993 and Dean of the College of Agriculture from 1993 to 1998. During the past decade, we have made a number of changes at Montana State University; changes that I believe serve our students, our state and our nation well.

We continue to pursue a strong base of programs in agriculture and natural resources at Montana State. Several years ago, we were able to add a plant biosciences facility, partially funded by USDA, through a program that, unfortunately, no longer exists. We have moved into promising new areas in animal infectious diseases and biotechnology. Federal R&D funding has been significant but far from sufficient to meet the needs for research and infrastructure as agriculture and natural resources, like other areas, have become increasingly sophisticated.

During the last decade, Montana State University has experienced exponential growth in research areas. Since 1990, our external grants and contracts have increased about 400%—from $17 million in l990 to about $70 million this year. MSU was awarded one of the early NSF Engineering Research Centers (ERCs) and in a field, biofilms, that was, at the time, an emerging, relatively unsupported field. Our ERC has served as the model for biofilms programs in both the environmental and health fields and remains widely recognized. We have also developed a strong program in optoelectronics, in which our faculty is engaged in cutting edge research and which also provides laboratory facilities and support for many of the optoelectronic companies that have been created in the Bozeman area. This interaction with local business and industry has been beneficial to the university and the community. We have established one of the early programs in thermal biology, building both on the expertise of our faculty and our location near the thermal pools and soils in Yellowstone National Park. We have recruited a world-class cluster in neuroscience that is highly competitive for research funding. We are developing a major new program focused on fuel cell technology. We have the only Master's degree program in the nation in science and natural history film-making.

Our research efforts are diversified, but focused. And, they are good. Our researchers are widely published and are winning competitive research awards. Our students are also successful. MSU ranks among the top schools in the country for the number of students who have received the nationally prestigious Goldwater Scholarships for undergraduate excellence in mathematics and science. This year's recipients are Zeb Barber of Belgrade, a junior studying laser optics; Sara E. Maccagnano, of Churchill, a 30-year old senior studying solid physics; and Britany Moss, 18, of Bozeman, a junior in biochemistry. The 2002 awards bring to 40 the number of MSU students who have won the scholarships. This places MSU sixth among the top ten institutions across the nation in the number of students receiving Goldwater Scholarships. In order, the top ten universities are: Harvard/Ratcliffe, Princeton, Duke, Kansas State, California Institute of Technology, Montana State,

University of Chicago, Penn State, University of Illinois at Champaign/Urbanna, Johns Hopkins and Washington University in St. Louis.

Most of our students attribute their success to participating in research projects. Cutting edge research opportunities are available to students at all levels through the Undergraduate Scholars Program, funded through EPSCoR, and other programs on campus.

In addition, two Montana State University seniors, Phenocia Bauerle and Kay Kirkpatrick, were named to the 13th annual All-USA College Academic Teams this year, bringing to 17 the number of MSU students selected since the program began in l989. An MSU undergraduate won the Alice T. Schafer Prize for the nation's best female mathematics student. Three students who previously received Goldwater Scholarships while at MSU won 2002 Graduate Research Fellowships from the National Science Foundation.

I believe these figures indicate that Montana State University has an excellent track record in integrating research and teaching and helping to prepare the mathematicians, scientists and engineers of tomorrow. In addition to awards for individual students, our faculty have been granted two highly visible competitive awards—a Center for Learning and Teaching (CLT) and an Integrative Graduate Education and Research Traineeship Program (IGERT) award by the NSF. Furthermore, we have operated a student research experiences program, using EPSCoR funds, that has supported more than 300 students. At Montana State University, we are developing a new core curriculum and a major focus of the new program is to integrate discovery and learning. We have initiated a highly focused program of freshman seminars and sophomore research experiences courses. Our goal is to eventually have every incoming student engaged in a freshman seminar and the sophomore research core.

I give this background for several reasons. One is to illustrate the quality of research that is being undertaken in the EPSCoR states. Another is to demonstrate the contributions that our universities are making not only in education and research but also to the community and state.

I am very proud of our achievements at Montana State University. I believe they are the outgrowth of several factors: the most important one is undoubtedly the ability to attract and retain good faculty who can win competitive awards. Another is the support that we have received from elected officials both on the federal and state level. A third is the commitment of two of our MSU presidents and our administration to identifying research areas where we have strength and finding the resources to pursue those areas. A fourth is the ability of a university such as MSU to integrate learning and discovery on our campus. And, fifth, but not least, is the support that we have received from NSF, the Congress and this Committee for the EPSCoR program and related efforts, such as computing and networking.

Despite our success, I am acutely aware that we will continue to need substantial federal research funding, in particular EPSCoR funding and computing and networking support from the National Science Foundation, and infusion into the larger research community if we are to advance our research agenda. EPSCoR was created in the National Science Foundation and in its early years allowed states like Montana to encourage and support a limited number of principal investigators and to begin small research projects. Perhaps more importantly, however, it awakened us to the importance of R&D—both for our institutions and states—and helped us become aware of opportunities and possibilities that we might not otherwise have pursued. It has helped us focus the university's goals of becoming more competitive nationally, thereby contributing to the nation's knowledge base and to economic growth in the states.

A major obstacle for many "less research intensive" states and institutions has always been the lack of infrastructure. By this I mean we do not have adequate equipment or the special faculty hire or the faculty support package that would enable us to develop research expertise in a select area. EPSCoR is helping us develop that infrastructure.

NSF recently implemented a new EPSCoR infrastructure program. Montana was one of the first six recipients of funding under that new program. And, I can tell you that program is what we need at this particular time. It will, for the first time in the EPSCoR program's history, give us a credible investment over a period of time that will allow us to develop the clusters and centers that are necessary if we are to be truly competitive. Most EPSCoR states have yet to receive funds under this program. None have been through a complete three-year cycle. *My most important request of you is to fully fund this program and let it fully operate over the next few years*. Capacity building takes time, as NSF and other agency efforts to create centers at major universities in the l960's indicates. This new EPSCoR infrastructure program is a good one. Let it work! This infrastructure program, together with

similar efforts at NIH, are the base for future competitive research activities in almost half of the states in this nation.

I would also like to make a plea for continued support for advanced computing and networking in our states. Several years ago, when NSF started its new networking program, it appeared as if the EPSCoR states would be left out. In fact, of the first 57 awards made under the vBNS high-speed connections program, only one went to an EPSCoR state. Thanks to efforts within NSF—and strong support from this Committee—the program was expanded, supplements were provided and ultimately, there was at least one connection in every state. About the same time, the President's Information Technology Advisory Committee (PITAC) was formed—initially without a single member from an EPSCoR state. Again, thanks to this Committee, especially to Senator Burns, Senator Lott, Senator Hollings and Senator Rockefeller, and to support at NSF, we were able to have two appointments made from EPSCoR states.

I single out advanced computing and networking for several reasons. First, they are of particular importance to the EPSCoR states. Most of the EPSCoR states are either rural and sparsely populated or serve large numbers of under-represented groups, two categories where connections and advanced computing capabilities tend to be most lacking. Secondly, our rural areas are where these services tend to be the most expensive. The digital divide is largely about money. Thirdly, advanced computing and networking are so important because they are the principal means by which people in rural states can overcome the limits of geography. With advanced computing and networking capabilities, we can enhance the educational offerings for our students, have our faculty collaborate with scientists at distant points, access and use equipment at remote sites and manipulate and analyze large data sets located elsewhere. All of this means more advanced research capabilities on our campuses.

Advanced computing and networking are infrastructure, especially in the rural and EPSCoR states. They are our lifeline to the larger research community, to research competitiveness and to recognized research expertise for our institutions. For that reason, I believe that advanced computing and networking are areas where there must be special efforts to insure that all states participate fully in federal programs.

Facilities continue to be a major challenge for institutions such as Montana State. We do not have the resources and endowments that many institutions have. The opportunity for raising large sums from private sources is limited. Yet, increasingly, our researchers need state-of-the-art laboratories and facilities if we are to pursue the latest research opportunities. And if we are to make the most of major increases in NIH and NSF funding, additional facilities are vital. At this very moment, MSU has access to major equipment valued at $850,000, which would be a major asset for our nanotechnology group, but we cannot take possession because we do not have a proper facility for it.

A strong instrumentation program at NSF is also essential. Ultimately, research success depends upon researchers. And, it is difficult to attract and retain good researchers if you cannot provide them with the tools necessary to undertake their research. Start-up costs for new hires in the sciences continue to rise. We are fortunate that new technologies and new equipment allow us to dramatically expand our horizons, but that comes at a cost and if a university cannot meet those costs, then its research activities will falter.

Finally, I would like to comment on participation or inclusion. For many years, researchers from EPSCoR states were seldom found on review panels or advisory committees. Some efforts have been underway at NSF to rectify this lack of representation and, in some programs, we have seen real progress. In others, we still have a way to go. Serving on such panels is vital to integrating our researchers into the over-all research community, as is the technical assistance provided by NSF through the Centers Development Initiative (CDI). I mentioned the earlier experience with PITAC, where this Committee helped secure representation for EPSCoR states. We currently have no one from an EPSCoR state on the PCAST and only two members from EPSCoR states on the National Science Board. This is important. Please do not forget us.

In a recent discussion, someone asked me what the EPSCoR states really want. There is no one answer. But, I have tried to suggest several. We want a truly national—and international—research community. We believe that almost half of the states in this country should be sharing a bit more than 10 percent of all federal R&D. We want a vibrant and widely dispersed networking and advanced computing infrastructure. We need help with facilities and equipment. We need a strong and fully funded EPSCoR program, and for that we need your continued support.

Legislation has been introduced in the House of Representatives to move toward a doubling of the NSF budget. The Coalition of EPSCoR States supports that legislation. I believe, however, that any doubling should have focus. There must be priorities and a roadmap for where we are going—and EPSCoR should be part of that roadmap to assist the 21 states and Puerto Rico that participate in the program. We also support legislation to expand networking and advanced computing programs at NSF, again making a special effort to see that this infrastructure is widely dispersed.

We appreciate the work of this Committee and look forward to working with you. Thanks for giving me the opportunity to testify.

Senator WYDEN. Thank you, Mr. McCoy. That was very helpful. Dr. Torr?

STATEMENT OF MARSHA R. TORR, PH.D., VICE PRESIDENT FOR RESEARCH, VIRGINIA COMMONWEALTH UNIVERSITY

Dr. TORR. Mr. Chairman, Senator Allen, I'm very pleased to have this opportunity to talk with you on behalf of Virginia Commonwealth University, a research university, and the relationship that federal funding has to the wealth of human capital, knowledge advancement and economic impact that these institutions continually produce.

These top 100 research universities provide an advanced educational experience to 2 million undergraduate students and 280,000 graduate students in a very distinct learning environment that is really forged by the relationship of the federal government to these universities over the past 50 years.

Virginia Commonwealth University is a public university. It includes one of the nation's oldest schools of medicine and the nation's very newest accredited school of engineering. This year we will receive approximately $160 million in competitive externally funded awards for our research and training, and over 64 percent of this will be from the federal government. So, like our peer institutions, it's primarily our relationship with the federal government that makes us a research university. This is our principal means of doing creative research.

These resources provided by these funds allow us to recruit leading faculty, they allow us to compete for strong graduate students. And the caliber of these individuals sets the character and the tone of much of the university, most of which is the undergraduate enterprise. At a research university, the undergraduates would not have the advanced learning experience they have if we did not have the ability to attract and retain quality individuals as a result of our federal research funding.

The need to stay state of the art in facilities and equipment poses great challenges for institutions like VCU. This means adding new, modern laboratories and renovating facilities that often were constructed in the 1960s and the 1970s.

The NIH has a very significant program that supports the reconstruction of university research facilities. We've just been awarded one of these. It will allow us to renovate 10,000 square feet of outdated space into a state-of-the-art laboratory to study the pathways by which cells develop diseases like diabetes and cancer. This new facility will allow us to attract three strong new researchers. Our students will learn from these faculty, and they will experience these facilities.

A comparable NSF program to assist institutions such as us to renovate our outdated chemistry and physics and math facilities and laboratories would be of enormous value to Virginia Commonwealth University, and it would influence the decision of students to choose the sciences and mathematics.

VCU is the international leader in comprehensive traumatic brain injury and rehabilitation. If you suffer traumatic brain injury in Washington, D.C., or in the forces in Afghanistan, you will be managed in accordance with principles developed and researched at Virginia Commonwealth University with the advanced edge that has been given through federal research funding.

The annual cost for treatment for traumatic brain injury in the United States is over $35 billion a year. VCU's research will lead to a reduction in that cost.

But our ability to deliver on the full promise of the alignment of our institution around the life sciences is inherently limited if we cannot integrate the ideas and expertise of our chemists in the production of nano-devices to assist in molecular imaging, our physicists in the shaping of particular beams in new ways for cancer therapies, our chemical engineers in the development of bio-chips for diagnosis and therapy, our mechanical and electrical engineers in the development of advanced limb replacement and robotic assists, and our mathematicians in imagery reconstruction and interpretation. To contribute at the level needed, these scientists must have achieved a level of excellence in their own fields first. That comes from competitive research funded primarily by the National Science Foundation.

The Congress will not make a better investment this year than the over $24 billion it will invest in basic research to support the research universities and their infrastructure. The footprint of that investment is national, it is extensive in time, and it has major international dimensions.

Mr. Chairman, I want to thank you and Senator Allen for giving me this opportunity to tell you about the very pivotal role that federal funding from agencies like the NSF have in shaping the nature of our research universities.

[The prepared statement of Dr. Torr follows:]

PREPARED STATEMENT OF MARSHA R. TORR, PH.D., VICE PRESIDENT FOR RESEARCH, VIRGINIA COMMONWEALTH UNIVERSITY

Introduction

Mr. Chairman and members of the Committee, I am pleased to be here today and to have this opportunity to speak on behalf of a research university and the relationship of federal funding to the human-, knowledge- and economic-capital that these institutions continually produce.

Amongst the spectrum of higher educational institutions in the United States, the top 100 research universities provide an advanced educational experience for over 2 million undergraduate and 280,000 graduate students in a distinct learning environment that has been formed by the strong relationship between the federal government and the research universities over the past 50 years. These institutions produce 75% of the nation's Ph.Ds (and hence most of the faculty of all the universities and colleges), their graduates are a national wealth in human capital that includes our teachers, engineers, scientists, architects, lawyers, business leaders, physicians, and so many other groups of people on whom we depend. These institutions conduct half of the basic research that is done in the United States—every year pushing out the boundaries of knowledge. The ideas and inventions of that research have led to a substantial return on the investment in terms of new products—and

the associated new companies, new jobs—that have led to such improvements in our quality of life.

Virginia Commonwealth University—and federal funding for its research

Virginia Commonwealth University is a public university that includes one of the nation's oldest schools of medicine and the nation's newest accredited school of engineering. In federal obligations for science and engineering R&D, we rank 88th and second in Virginia. This year we will receive approximately $160M in competitive externally funded awards for our research and training, of which 64% will be from the federal government, and 12% each from state, foundation and industry sources. So, like our peer institutions, it is our relationship with the federal government that makes us a research university. These funds will support almost 1000 research projects. While we are one of the largest academic health systems in the United States, and the largest part of our federal funding is from the NIH, the impact of what we are able to do would be severely limited without the integration with advanced capabilities in our other disciplines. For example, the work we do in tissue regeneration in our school of medicine depends on the work done in our school of engineering in advanced polymers that has led to nanoscale, biocompatible tissue support scaffolds. Work funded in one field by the NIH has now merged with work funded in another by the Department of Defense and the NSF to become more valuable. VCU is the largest employer in Richmond and one third of all Virginia indigent care is provided in our hospital. But the ideas and inventions of research add substantially to its economic impact. In the example given here, the research has led to a promising Richmond-based start-up company. Last year VCU was involved in the start-up of seven companies. As a result of our research, VCU together with its Biotech Research Park has had an extraordinary role in the renewal of inner city Richmond.

VCU is typical of public research institutions in that there are few means of supporting creative research other than the efforts of faculty who write proposals to funding agencies and are successfully awarded grants or contracts to fund their work. The research enterprise in such a university must essentially stand on its own financial base. Approximately one dollar out of every five coming into the university is in the form of a grant or contract. These external research funds are woven through most of what we do. This funding establishes the caliber of the education we offer. This year Virginia Commonwealth University will receive about $100M in federal funding for research. This includes about $20M in facilities and administration costs to cover the shared support of the grants management, accounting, human subjects protection, research animal care, handling of hazardous materials, and research facilities. With the scope and cost of compliance expanding continually and the rate at which technology becomes outdated, it is vital that the grants cover the cost of the university's research support structure that must meet a broad front of regulation.

The largest portion of the $100M in federal funding that we will receive this year is spent on salaries for the people who work in the research enterprise: the salaries of our research faculty for the time that they spend on research vs. teaching or clinical responsibilities; the stipends for the graduate students who serve apprenticeships in the research programs; the salaries of post-doctoral fellows—many of whom will become principal researchers and teachers themselves; and the salaries of the technicians, data and computer specialists, and assistants all of whom make up the research engine of the university. The federal funding provides the resources that allow us to build a base of leading faculty and allow us to compete for strong graduate students. The caliber of these individuals then sets the character and tone of much of the university—most of which is the undergraduate enterprise. Our undergraduates would not have the learning experience they now have if we did not have the ability to attract and retain such faculty as a result of this $100M in federal research funds. And, of course, these funds buy the advanced equipment and supplies that are essential to research. This means that employers hiring our students know that they have been exposed to state-of-the-art environments and approaches to problem-solving and dealing with complex issues. Their experience has not been limited to textbooks and problems with known answers.

The University invests a portion of the recovered shared costs in maintaining our competitive edge: an important part of these funds goes into the so-called start-up recruitment packages for new faculty—the funds to get them and their research teams competitively launched. We use a portion of the indirect costs to reward productive departments and groups with additional funding for graduate student assistantships and to mentor new faculty as they begin a research career. As a result of these bootstrapping efforts, VCU grew in federal funding by 17% last year and will increase its federal funding this year by 20%.

This enhancement is what enriches our educational value and the quality of the engineers, physicians, educators and social scientists that we graduate. This growth in our research capabilities and expertise is the magnet that attracts sponsors from the private sector. Companies would not have an interest in partnering with us if we did not have the leading edge researchers and facilities that are made possible by our research grants from the NSF, NIH and DoD.

The growth and the need to stay ever state-of-the-art in facilities and equipment poses great challenges for the institution. We have an increasingly urgent need for modern laboratory and research space. This means adding new space and renovating facilities constructed in the 1960's and the 1970's. The NIH has a program that supports the construction or reconstruction of research facilities. This has enormous value for universities like ours. I am able to use part of the indirect costs recovered to provide 1:1 matching funds for a grant from NIH that will allow us to completely renovate 10,000 square feet of outdated space into an advanced laboratory to study the pathways by which cells develop diseases such as diabetes and cancer. The promise of the new facility is allowing us to recruit three strong researchers in this area and we will soon have a nationally leading group that has critical mass enough to make an impact. Our students will learn from these faculty and experience these facilities. An NSF program to assist institutions renovate their outdated chemistry and physics and math facilities would be of great value to VCU and would influence the decisions of students to select science and mathematics programs.

VCU is the international leader in comprehensive emergency-room-to-return-to-workplace traumatic brain injury care. This strength includes neuroscientists, neurosurgeons, neuropharmacologists, psychiatrists, psychologists, and rehabilitation specialists and spans five of the schools within the university. Last year represented our 27th year of continuous federal funding in this field and saw over $14M in competitive federal funding for our research involving the brain. The efforts of our researchers have resulted in the survival rate of traumatic brain injury being improved by 30%, over 1200 papers in the literature, and one-third of all the clinical trials of new drugs for brain injury treatment have been designed and executed from our hospitals and clinics. If you suffer traumatic brain injury in Washington DC or in our forces in Afghanistan, you will be managed in accordance with principles developed and researched at VCU as a result of the critical mass of expertise that has been built and the leading edge it has been given with federal basic research support. Three years from now we hope to inhabit our new Brain Research Institute that will allow us to co-house for the first time, 30 of these international leaders and their research teams around shared core facilities. The State of Virginia will provide funds for the construction of the building itself, but only with partnership with the federal government can we acquire the advanced facilities and retain and enhance the research teams who will change the outcomes of traumatic brain injury. The annual cost of treatment for traumatic brain injury in the United States is estimated to be about $35B. VCU's research will lead to a reduction in this figure.

However, our ability to deliver on the full promise of our commitment to the life sciences is inherently limited if we cannot integrate the ideas and expertise of our creative chemists in the production of nanosignaling particles to assist molecular imaging; our physicists to work with the shaping of particle beams for cancer therapies; our chemical engineers to develop the bio-chips for diagnosis and therapy; our mechanical and electrical engineers to work in the development of advanced limb replacement and robotic assists; and our mathematicians to work in image interpretation. To contribute at the required level, all of these must have achieved a level of excellence in their fields that comes from competitive research funding primarily from the National Science Foundation and the Department of Defense. The development of our integrated strength and impact is tied to NSF and DoD basic research funding.

The federal government will not make a better investment this year than the $24B it will invest to support basic research and the research infrastructure of our research universities. The footprint of that investment is national, extensive in time, and has major international dimensions.

Conclusion

Mr. Chairman, I want to thank you and the Committee for giving me this opportunity to tell you about the pivotal role of federal research funding in shaping the nature of our research universities—one of our most vital national assets.

Senator WYDEN. Thank you very much, Dr. Torr. Our thanks to all of you—and a very good presentation.

Let me begin with a question for the Speaker and Mr. Podesta sort of born out of your experiences up here. As you know, you see your typical member of Congress, and they get up in the morning, and it's 8 o'clock, breakfast with the grange, 9 o'clock, head to the subcommittee on acoustics and ventilation to talk about some vital matter, and, you know, the whole day is essentially jam-packed full of these kinds of things.

Senator Allen and I have had a special interest in these issues, science and technology, so we make time to get over here. But obviously, it's a challenge to get members of Congress involved in these questions. And we're going to call on you as we wrestle with this sort of OTA versus, Academy of Sciences approach. I gather there's something in the energy bill that sort of is an amalgam of those kinds of principles.

But let me begin with you two by way of saying, are there other ways that we could get Congress serious about science issues and tackling science questions that people would see as something that, would be politically viable and allow us to make significant headway on these questions? Mr. Speaker, do you want to start?

Mr. GINGRICH. Sure. Let me just say, I think that scientists themselves have an obligation. I mean, all of these scientists and all of these universities have to occasionally get out of their lab and away from their lecture hall and go to a town hall meeting and go to a congressional or senatorial office and make a case.

And I know AAAS has worked for years. I've been a member for many years, and we've worked for years on getting scientists to understand they're citizens, too. They're not above the process of politics, and they're not above the process of explaining the legitimacy of what they're doing.

Second, though, I would sort of break the—this is probably a little bit too simple, but I think it gives you a notion—I would break the large, complex idea of scientific knowledge into four practicals, because I think many of our colleagues, my former colleagues, respond more rapidly to practical things—jobs, health, defense, and then science as a contributor—and try to drive home the case that what you are describing is, in fact, the next Silicon Valley, the next job creation, the next wealth creation, the next Reston area in your state, Senator, or the next Portland area. What we're describing are the jobs of the future. We're describing aspects of health.

I mean, in every district in this country, there are people alive today who would be dead without the advances of science in the last 30 years, period. I mean, just—I mean, if we just have a rally in each state of the people who literally would not be here if it weren't for science, it would begin to drive home how serious this is.

Third is defense. I couldn't—I cannot overstate the national security implications of sound science. I mean, if lose—if we don't catch the wave of the scale of change that's coming, we will not be the leading power on the planet in 20 years. And it's not a question of economic growth. It's a question, as the Iraqis discovered, as the Afghans discovered, of just literally being outclassed at such a level that you don't even understand what's happening to you. And there's an enormous danger there.

And the last is just the sheer excitement of science. I happen to love the natural world, and I love, for example, Jack Horner and what he does with dinosaurs in Bozeman. And I believe that there is an exciting educational adventure story to be told in every congressional district and every senator of what science means in giving the human race hope for a better future and a future of vastly more opportunity.

Those are the kind of themes I'd try to use, to then say, "By the way, this is called science funding." But it's start with the end result, and then come back to why you need the money.

Senator WYDEN. Very good.

Mr. Podesta?

Mr. PODESTA. Well, it's hard to add to that. I think that—let me say two things—I think the success of the NIH funding stream is the direct result of real people meeting with members of Congress and saying, "This affects us each and every day." And that's, I think, why you've seen the support, which I think is terrific, go up. And that's, I think, what we need.

But let me tell you one little quick story, which is—which goes to the last point that the Speaker made. The President, each week, used to get—President Clinton used to get, in the White House, a weekly report from every office in the White House, and it was sort of his way of staying in touch with what was going on, and he used to read those on Sunday night, and he had a habit of marking them all up and giving us a lot of work to do.

I think the one that was always the most marked was—and I think you might find this surprising—was the memo from our science advisor from the Office of Science and Technology Policy, because there was exciting material in that report. It was a page or two, but the latest developments, the most interesting things that were going on always caught his attention, and I dare say I think they would catch the attention of most members of Congress who, if they knew what was going on and had that presented to them in an interesting format, would say, "This is really important stuff, and I've got to learn more about it."

Senator WYDEN. That's interesting. I mean, in a sense, you're saying if you could put, in a member of Congress's hands, something along the lines of what got to the President every Sunday night, people would walk away—if not whipped up into a frothing of excitement——

[Laughter.]

Senator WYDEN.—but by Monday, start of the week, they'd see how some of this stuff was really interesting and worth the time.

Mr. PODESTA. I believe that.

Senator WYDEN. That's very good. All right.

One question for you, Dr. Leshner, and then I'm going to recognize my colleague. Be the devil's advocate for a moment—or let's say the devil's advocate is around, and somebody doesn't want to double the NSF, and basically says, "Aw, they can do with, you know, the money they've got. It's just fine," and the like. If you had to respond to that, what would a larger NSF be able to do that it can't do now?

Dr. LESHNER. One of the things that I think is important to keep as context is the fact that NSF grossly under-funds every single

grant that it makes, because it's trying to maximize the number of grants. So you could actually, tomorrow, double the size of every grant, have no negative effect on—you know, you would not be under-funding that grant. That is to say you could literally double every grant, double the budget instantly and consume all the money in an extremely productive way. So that's point one.

The second is that the array of opportunities throughout the entire science and technology enterprise, when we're funding, at most, 20 to 30 percent of the excellent proposals that come in, the array of opportunities lost is tremendous. And, as our colleagues just pointed out, if we don't take advantage of those opportunities, we fall risk to becoming stragglers in the age of technology in the same way that so many other countries are fearing themselves to be.

So I would argue that if we could just catalog—and perhaps for our joint colleagues—if we could catalog the opportunities, you could run through them very rapidly, and you would discover that doubling or perhaps tripling funding for science in this country would be a wonderful investment.

The data speak. It's happened before.

Senator WYDEN. Very good.

Senator Allen?

Senator ALLEN. Thank you. The witness has addressed many of the questions I had, and I'd like maybe Dr. Leshner, Dr. Torr, and Dr. McCoy—if you'd comment on this.

As far as regulatory burdens or regulatory constraints, I mentioned in my opening remarks, and I've heard it from some universities, that the regulatory burden is costing universities, maybe such as VCU, for example, in terms of reduced research. Dr. Torr or Dr. Leshner or Dr. McCoy, would you—any of you all want to comment on that concern and what we can do to make sure the research is actually being done and not having any regulations diminish that capability?

Dr. TORR. I think we all recognize, Senator Allen, that research and advanced research has with it significant responsibilities, and there are responsibilities to manage the financial resources that are provided to us well, and the responsibility to take very good care of participants in research—human participants in research, and animal subjects used in research. And we take those responsibilities very seriously, and we recognize the need to regulate that.

It is expensive. And I think we would ask for your help in making sure that we are able to cover those costs as part of the federal grants and contracts that we receive.

I don't know if you're aware, but part of the indirect shared costs that we recover to support meeting all of that growing burden of compliance are capped. And so we actually must underwrite part of the cost of research from institutional funds that, as public institutions, we generally do not have an alternative source for.

So just as Dr. Leshner has said, NSF could really get far more out of fully funding the research projects it funds, and I agree with that. We would have much of the burden of complying with regulation, which we accept and realize must be there, if it did not come with such a punitive financial component to it in terms of our having to pay for it out of monies we really do not have.

Senator ALLEN. Mr. McCoy—Dr. McCoy?

Mr. MCCOY. I would just concur. And basically, to me, it's one of these situations that the requirements, when they're appropriate, they're not overly burdensome. It comes down to money. And when they come as unfunded mandates, it is a problem.

But otherwise, a lot of these things that are coming down are appropriate. I mean, I think that everybody is much more sensitive to animal use and care issues, human subject issues, and those types of things, and we all want to make sure that we're doing the right thing. But, as my colleagues already said, when they're not funded, it is a burden for the institution.

Senator ALLEN. Thank you. Dr. Leshner?

Dr. LESHNER. I would just quickly add that it's important that the scientific community itself understands the complexity of the issues with which we're now dealing, and that we are getting closer and closer to issues that go to the core of our humanness. And, therefore, it requires a degree of regulation. It requires a degree of oversight that we've never had before—human subjects issues, animal research issues. These are issues that require close scrutiny, and we in the community recognize the need for that. So we do understand that.

At the same time, we need to have the infrastructures in place that allow us to do it. We need to have the financial support, and we need to have the guidelines and the principles. And, again, we in the scientific community are working continuously to improve the quality of those guidelines to make sure that we are, in fact, being responsible.

Senator ALLEN. Thank you. That just means that the grants need to be more realistic as to what your overall costs are in that research. Thank you, that's a good clarification for some for some of these concerns.

Mr. Podesta mentioned not earmarking NSF funds. He also mentioned—and I think it was very insightful—the reason NIH is increased. You have folks who have cancer or heart diseases or the family's children have diabetes, and those are real, live people that you think of when you're making those funding decisions.

Some of the NSF issues, much of that research is—you don't necessarily know where it's going to lead. You know it's beneficial, it's all interrelated, and you'll never know how something in the space program ends up affecting lipstick or sunblock or who knows what it may be, but other commercial uses, and so that makes it harder.

Now, one thing that you hear, though, from—I've heard from time to time—is that in the NSF programs, they tend to favor the more well-known research institutions when awarding grants based on—well, we have two from universities here, Montana State and Virginia Commonwealth University. Do you believe that that's an accurate statement, that there's a favoritism to some of the more well-known universities insofar as the awarding of these grants, NSF grants?

Either one of you all—I'd like to hear from both of you all. And if Dr. Leshner wants to—or the Speaker—whenever the Speaker wants to say something, I always want to listen, but I know you all are—it gets to Mr. Podesta's point in an indirect way.

Dr. TORR. Senator Allen, I think it gets down to where the existing strength and capability is at any one time. And if the size of a budget is frozen around an existing set of established institutions, then those continue to be the ones primarily that will receive those funds until there is a growth in the budget for the agencies that supply those funds.

And so earmarking, I think, is very much a creature of institutions growing to meet national need. But the budget growth is not there in trying to break in, in order to establish great capabilities from which they can continue to compete. It's a way to get people launched to be competitive.

So one can achieve that same end with a rational growth in the funding of these agencies and programs like the NSF has had for underdeveloped states, the EPSCoR program, to which my colleague has just spoken, and programs like the NIH has developed to bring emergent institutions into pre-center development of faculty, and development of capabilities that then position them to go into the mainstream competition with all those other institutions.

So I think as long as we can continue to do that, then the strong emerging components of universities are able to enter the field and compete with anybody.

Senator ALLEN. Thank you.

Mr. MCCOY. Senator Allen, I would, again, concur with my colleague and just add a couple of points. Personally, I don't think that it's necessarily a situation where there is favoritism on the part of larger universities in terms of review panels relative to reviewing a proposal more positively from a larger research university versus a smaller research university like Montana State. The big issue is the issue that I was trying to emphasize in my testimony, which has to do with this infrastructure issue.

And, really, where we need to be able to grow with a program like an EPSCoR program, like the IDeA program in the NIH, is that enables us to literally go out and hire additional faculty, that if we don't have some of those federal assistance dollars, these are dollars that are matched with state dollars, in terms of building these programs, it is now enabling us to actually go out and hire absolutely stellar scientists from large research universities that, in the past, we may have had much more difficulty doing.

And I sincerely attribute our 400 percent growth in research in basically a decade to the ability to build our infrastructure. And I would just reiterate that the EPSCoR program, now the IDeA program, is allowing us to continue to do that, expand that. And I hope to see, in the next decade, another 400 percent increase in our grants and contracts expenditures.

Senator ALLEN. Well, it's important for us to recognize that most of the research, while it's done in various federal agencies and other agencies, much of it is in our—is conducted in our universities, which is important for the research, but it's also important for the education and the attractiveness and having students actually involved in the research so that when they leave the universities, their graduate programs, they enter into the private sector, or some may go into the Department of Defense, or who knows where they may—they may go into NASA and various agencies there. But nevertheless, they actually are conversant with it.

They've been doing that hands-on research, and they are very valuable to a private company that may be also a partner in some of that research.

Mr. Speaker?

Mr. GINGRICH. I want to just, if I could, Senator—I think you asked a very profound question. And it actually, I think, goes back to something that the Chairman and Dr. Leshner discussed.

Let me start by saying the distribution is actually a symptom, not a problem. That is, if you had equally strong institutions with equal infrastructure, you get a very significant different distribution. And so I would focus not so much on where do they make the grants, but how do we strengthen institutions across the country.

A specific example. If the federal government only sets a limited number of supercomputing facilities at specific places and then builds an Internet connectivity to handle that level of data between those data, you've just defacto described who's going to go to bid on certain sets of problems, period.

And one of the reasons I'm for such a dramatic increase in the budget is, we need to wire, with scientific volume of data flow, every major institution in the country. And the truth is, we need to wire every high school lab in the country, and the high school labs are in worse shape than the college labs. So you have kids who are told, "You have great football equipment. But, by the way, we don't have anything in the chemistry lab this year."

And we just need to be honest as a country about the scale of investment you're describing if you want every child to really have access, and every person in a minority community or a rural community. That's the second.

Part of this becomes a "circle of timidity." And I was just asking Mr. Podesta, when he was the number-two guy in the White House under the President—I guess number three if you count the President as number one, or number four if you want to count the Vice President——

[Laughter.]

Mr. GINGRICH.—but he was the Deputy Chief of Staff. And we worked endless—what seemed at the time to be endless hours on getting to a balanced budget, and I am very proud that we did that. But we did it very selectively. There were some things that were going up, like NIH, and other things that weren't going up, and it was hard.

But one of the reasons we could do it was both the White House and the Congress had reached the conclusion to break out of what I would call a "circle of timidity." And that circle—and you both will remember—was, well, you have this big a deficit, and you can only change it at the margins. It's really not worth fighting over the margins, so we never quite got around to doing anything. And we got into a dialogue that said, "No, let's talk about what would it, balanced, be like?"

Well, this is the same thing here. I wrote a piece for the—I think it was in Science a year ago—that said if you were to go out—and this Subcommittee might be willing to do this—and ask the scientific community, "Don't tell us in a circle of timidity. If you had four percent more to spend, what would you do next year?" Tell us

what the opportunities are in science which, if we were funding them——

And the model I used was the international geophysical year of 1958 to 1960—it was actually an 18-month year—which revolutionized geology—absolutely turned it on its head overnight, because suddenly we found out, by doing a series of deep hole bores that had never—we could never have done without that scale project—that all of our current theories were just plain wrong. All of our current plate tectonics, all of our understanding of floating continents, all of our understand of modern paleontology comes out of that 18-month dramatic breakthrough.

If you went back to the scientific community and said, "Tell us what you would dream of if you thought a budget was possible," you would be startled at the opportunity.

And to come back to your point, Senator, I actually think it would be useful to have the President's science advisor pick up on your theme and once a week send every member in the House and Senate the five most interesting things and what they might mean, because you'd start to discover, for example, down at the nano level, the American Cancer Society believes they may literally cancer within 15 years. Gone. It is conceivable with breakthroughs in brain science that by the time the babyboomers worry about Alzheimer, they won't worry about it. It is conceivable that breakthroughs in energy, you can begin to move towards fuel cells in a way that just breaks the back of current calculations, meets the California air standards, and liberates us of the Middle East.

But these are the kind of dreams that historically make us Americans, and we've gotten into this cycle in the science community of being practical. So we're only going to ask for the next set of practical things, and dreaming, frankly, is not practical, although, in the end, it changes the world.

Senator ALLEN. Mr. Speaker, as usual, you're very inspirational. That is the way that I think that we do need to present it. We're talking about balance here, balance there, and so forth, but what does this really mean?

And, in fact, in the energy bill, there were some differences in it. Some of the bad ideas that I considered bad were defeated. Some of the good ideas that I thought we needed for greater independence were not adopted. The one thing that I know that Senator Wyden and I agreed on were the new technologies for the future. Don't just keep thinking we're going to continue with internal combustion engine. Let's get to the hydrogen fuel cells and have incentives for marketplace acceptance. And I think that the automobile dealers, manufacturers, all the rest want to do it, and I think that the people will. And the sooner we can get to it—it is a national security matter, but it also is an environmental matter.

I see that there's no circle of timidity, or panel of timidity, here in your advocacy, and—nor should there be. As I said in the beginning, we should only be limited by our imagination, but you do need to inspire and motivate people.

And the Chairman and I were talking when John—Mr. Podesta was talking about the President getting these briefings. It fits perfectly as to some of the new ideas that are being considered. That's

why I love going to NASA Langley and seeing what they're doing there and those capabilities. And really it's inspirational.

The same at VCU. When trying to study and determine the science behind embryonic stem cell research—not that you're doing it on humans; you're doing it on mice—but, nevertheless, just the science, to understand the facts and then apply one's own values to that.

But I think that we could have a Wyden–Allen monthly report, or whatever. I think it's important for folks to know what is going on, because I think it's exciting. I only wish with some of the things that are going on, especially in the medical and life sciences, I were younger, because life will be better in future years. But it's important for us, as Americans, to lead. Our universities are absolutely essential in it.

And I'm also glad to see that many universities I know of—just speaking for the Commonwealth of Virginia, not every university has the capability of doing all these different things. Some have strengths, whether it's in microelectronics, some may be more in the biological areas. But what they're doing is teaming up.

And I recognize that sometimes whoever gets that grant is going to be the one that's going to get it from here on out, but you don't just see it within Virginia. You see them going across state lines, where they're dealing with Johns Hopkins and Virginia universities or universities in Texas, and it's good to see that sort of cooperation so that these competitions get the best out of all the people in all the universities in our country, as opposed to just, "Gosh, it's—Oregon's winning it all to the detriment of Montana," for example.

So it's great to have you all here. Thank you, again, Mr. Speaker for your inspiration, and all of your inspiration in what you're doing that's important for your students, but obviously very important for the future of our country and our economic security, but most importantly, really, our leadership in the world, because this is a country that, with this research, it will be put to good uses. This technology, as we well know, if, in the hands of people who don't have the values and the love of freedom and liberty that we do, can be quite harmful.

So, again, thank you all so much. And, Mr. Chairman, thank you for assembling such a wonderful hearing today for this Subcommittee. I hope all our members will read and will be inspired and will follow up with each and every one of you.

Thank you.

Senator WYDEN. Well, I thank my colleague. Senator Allen, I think you've asked just all of the key questions.

And what's striking about, particularly, this idea of a science report, you could put something like this on the Web and not only just have members of Congress, but have the country really look forward to the fact that, on a regular basis, they'd be able to get engaged, in a sense, at the highest level of government in state-of-the-times information about these kinds of questions. It was a very interesting discussion you all had with Senator Allen.

Just a couple of other questions, and then we'll let you go. On the nanotechnology initiative—and I know, Mr. Speaker, you're doing some very interesting and important work with this nanobusiness alliance and the like—I've been struck by how we're al-

ready starting to have people raise some of the social questions that underlie the technology questions. Dr. Bill Joy of Sun Microsystems said people are already asking, apparently, about the fear of tiny robots with minds of their own and the like.

As we wrap up, are you able, as you deal with these technology questions, to come up with some principles that you've been able to identify for addressing some social questions that underlie the technology debate? I mean, obviously, they're different, but what people always want to talk about are the various risks and benefits and the like. And more and more we're seeing particularly the opponents of some of these technology innovations raise these very dark, you know, ominous sounding kind of social, you know, ramifications. I'd be curious as to how you approach some of those social issues.

Mr. GINGRICH. Let me say, first of all, that I want to commend President Clinton on this initiative, because it was his Administration's leadership that identified and put together the National Nanotechnology Initiative, which I think was really one of the most important long-term investments the Administration engaged in. He deserves a lot of credit for recognizing it early. And it may have come out of those Sunday night perusings.

Well, look, I think there are two groups of dangers that are inevitable. One is things we generally don't understand. For example, I used to teach environmental studies. And if you look at the original case in Wisconsin on DDT, it is fascinating how we really didn't understand what the effects were on birds, what the effects were on the entire food chain. And I think that's—there are cases where you have to back up a half step and say, "Well, that didn't work."

Or, if you look at Britain, where they ran out of wood and began burning coal, and much of the fog of England was, in fact, simply smog. And London has much less smog today because they don't burn coal anymore and—but the hearths—nobody had any idea what the health side effects were of having open-hearth burning of coal in all of London for a 200-year period, but they were clearly—they were better than not being warm, but they were worse than modern central heating.

So I think there are things that are byproducts of technology that you've got to always be looking for, you've always got to be aware of. And over time, you try to compensate. And just—we were talking about the internal combustion engine, for example, which clearly has some impacts on air pollution and on global warming, versus moving to the next-generation solution with a fuel cell.

The other thing you have to worry about are certain kinds of technology—and I would say that engineered biologicals is one of these—where the—where you have to understand it, because the risk of somebody else understanding it first is so horrifying that you have—the very fear of it forces you to be really good at it.

And I think we've now come to the conclusion as a country that you actually have to have a very aggressive biological program just to understand what potentially could be done, either by a random nut—and I think it's going to turn out to be much easier to do than people thought five years ago. And I think the danger of an engineered biological may be the largest single threat on the planet today, larger than a nuclear war, as horrifying as that would be.

But I just would close with two other thoughts, and maybe this is why I'm a perennial optimist, as Senator Allen was sort of accusing me of being a moment ago. It's true. I always dream. I am always optimistic, and for two reasons. One is a great letter that was sent to Werner Von Braun late in the moon program at Huntsville, by a woman who said to him, you know, "Why don't you—you know, we shouldn't go to the moon. God doesn't want us to do things like that. Why don't you stay home and watch TV the way God intended?"

[Laughter.]

Mr. GINGRICH. And the lady had probably no sense that the technology she was used to was the revolution of the previous generation.

And as a historian, I would just suggest to you that while we haven't yet found in the cave writings, we will someday find the "anti-fire faction," having written on caves.

[Laughter.]

Mr. GINGRICH. And we'll also find that "bow and arrows are cheaters factions," saying, "Real men use spears. Only sissies use bow and arrows." Because I think it's been true of the entire human history that whatever the next phase of new knowledge was, the last group was going, "Boy, that's not right."

And some of this you just have to accept, digest, and keep moving forward within the framework I described.

Senator WYDEN. Very good. What a rollicking ride this afternoon has been, and I thank you for it.

Senator ALLEN. Most all of us want to ride horses, though, just for the fun of it.

Senator WYDEN. There you are.

[Laughter.]

Senator WYDEN. The only other question was for John Podesta. On the cross-agency initiatives that you all put together, how did you go about finding those? Because very often, I think, you know, one agency is percolating along with an idea, and another one is going at it, as well, and the two don't even meet.

You all put—and you see it in your testimony—put a lot of emphasis on inter-agency science initiatives, and that's something I think more ought to be done. Any lessons from what you all went through for making science policy today?

Mr. PODESTA. Well, as my written testimony talks about, I think that first the President had a vision about science as being a driver in the economy. And I think that he was quite interested in it and pushed it. I think selecting Vice President Gore, who was on this Committee and was one of the leaders on science policy, encouraged that.

But I think one of the things that was most important was drawing in—science policymaking into the White House, the creation of the National Committee on Science and Technology, bringing the Cabinet secretaries to the table, having regular meetings with those people, you know, chaired at the White House by the President's science advisors, developing that inter-agency guidance between OMB and OSTP so that each agency knew what the priorities would be, ended up helping to create a culture in which people shared rather than feeling like they were fighting against each

other for resources, both in the budget and the priority-setting process. And I think that that was all modeled, I think, after successful experiments really with the National Security Council, the National Economic Council. And that's, I think, a good model for trying to draw these various agencies together to see what the big opportunities are. Because just like the disciplines need to work together in this interdisciplinary approach to move science forward, and that's why the NSF is so important, so does, I think, the federal government need to organize itself in that regard.

Senator WYDEN. Well, I thank you all. And, you know, you really make science policy and technology policy come alive. And, in a sense, you know, budgets and a lot of the issues that we talk about, you know, in this town often look like just charts and figures and graphs and lots of white pages and black print. But I think what you've given us a sense of us is the hopes and aspirations of the public and the hopes and dreams that we're capable of reaching for.

So this has really been good. It's been almost like teach-in, in terms of science policy. Mr. Speaker, Mr. Podesta, you have, I think, driven home how important it is that these issues be tackled on a bipartisan basis, and I saw an awful lot of common ground. Our other panelists have been excellent, as well.

And unless you have anything to add further, we'll excuse you at this time. The Subcommittee is adjourned.

[Whereupon, at 4:59 p.m., the hearing was adjourned.]

A P P E N D I X

PREPARED STATEMENT OF WARREN WASHINGTON, CHAIR, NATIONAL SCIENCE BOARD

Chairman Wyden and members of the Subcommittee, I appreciate having the opportunity to testify before you as Chair of the National Science Board. I am Warren Washington, Senior Scientist and Section Head of the Climate Change Research Section at the National Center for Atmospheric Research.

On behalf of the National Science Board, I thank the Subcommittee for its sustained commitment to a broad portfolio of investments in science, mathematics, engineering, and technology research and education. These investments contribute to our Nation's long-term security and economic vitality and to the well being of all Americans.

The National Science Foundation's Budget Request

The National Science Board has approved and supports the National Science Foundation's budget request for fiscal year 2003. The 5 percent increase in funding will allow NSF to continue to nurture the people, ideas, and tools needed to generate new knowledge and new technologies. Among the important initiatives that this budget includes are priorities for the science and engineering workforce; mathematical and statistical science research that will advance interdisciplinary science and engineering; and research in the social, behavioral, and economic sciences to explore the complex interactions between technology and society. The budget continues support for the Math and Science Partnership program; increases funding for the Foundation's six priority areas, which have the potential of enormous payoff for the Nation; and provides a much-needed increase in annual stipends for graduate fellows—a critical investment the future U.S. science and engineering workforce. The NSF Director, Dr. Rita Colwell, will discuss these and other specifics of the budget request in her testimony.

As this Committee recognizes, NSF is a major contributor both to scientific research and science education. Federal investments in the basic sciences through NSF have produced new discoveries and new technologies essential to our national security and economic prosperity. In addition, NSF supports innovative education programs from pre-kindergarten through graduate school, preparing the next generation of scientists and engineers and contributing to a more scientifically literate workforce and society.

Each year NSF evaluates, primarily through external peer review, 32,000 proposals from 2,000 colleges, universities, and institutions. The value of the proposals is approximately $16 billion. NSF annually makes 10,000 awards, totaling nearly $3 billion, in a highly competitive merit review process. It is estimated that NSF proposals representing an additional $5 billion are worthy of investment if the funds were available.

The Health of the Science and Engineering Enterprise

The new knowledge and technologies emerging today are a tribute to Federal research investments made years ago in a spirit of bipartisanship. When those investments began, no one could foresee their future impact. Revolutionary advances such as those in information technology, nanotechnology, materials, and biotechnology remind us that such breakthroughs with promising benefits to the economy, the workforce, our educational systems, and national security require long-term, high-risk investments.

Among Federal agencies, NSF has the unique mission of advancing the Nation's health, prosperity, and welfare by supporting research and education in all fields of science and engineering. NSF plays a critical role in supporting new discoveries and knowledge as well as innovative educational programs at all levels. NSF-funded research and education are critical to sustaining U.S. strength in science and technology, a key element of national security.

Despite widespread recognition of the benefits that result from federally supported scientific research, as a Nation, we are seriously under-investing in basic re-

search. In our $10 trillion Gross Domestic Product, the Federal Government budgets $24 billion to basic research, which represents one-fourth of one percent of the Nation's Gross Domestic Product. Of the $24 billion, NSF receives $3 billion to support cutting-edge science and the search for new knowledge.

Achieving a balanced portfolio in the basic sciences is as important as the quality and quantity of research funded. For example, as Congressional leaders and others have pointed out, the success of the National Institutes of Health's efforts to find cures for deadly diseases depends heavily on the underpinning of basic research supported by the National Science Foundation.

National Science Board Policy Studies

In addition to providing oversight to NSF, the Board provides advice to the President and the Congress on matters of science and engineering policy. I would like to mention some of our current activities related to major issues affecting the health of the science and engineering enterprise.

Federal Investment in Science and Engineering

The level of Federal investment is crucial to the health of the science and engineering enterprise. Equally crucial is how effectively that investment is made. The growing opportunities for discovery and the inevitable limits on Federal spending mean that hard choices must be made and priorities set.

In its recent report, *Federal Research Resources: A Process for Setting Priorities,* the Board offers its recommendations for a more effective budget process, including an improved information base and a decision-making process for allocating Federal funding to research. The Board's conclusions are based on reviews of the literature on budget coordination and priority setting for public research and invited presentations from and discussions with representatives of the Office of Management and Budget, the Office of Science and Technology Policy, the Federal research and development agencies, congressional staff, high-level science officials from foreign governments, experts on data and methodologies, and spokespersons from industry, the National Academies, research communities, science policy community, and academe.

U.S. Government Role in International Science and Engineering

In the 21st century, advances in science and engineering will to a large measure determine economic growth, quality of life, and the health and security of our planet. The conduct, communication, and use of science are intrinsically global. New ideas and discoveries are emerging all over the world and the balance of expertise is shifting among countries. Collaborations and international partnerships contribute to addressing a broad range of international problems. They also contribute to building more stable relations among nations by creating a universal language and culture based on commonly accepted values of objectivity, sharing, integrity, and free inquiry. The Federal Government plays a significant role in promoting international science and engineering activities and supporting research with international dimensions.

In its recent report entitled *Toward a More Effective Role for the U.S. Government in International Science and Engineering*, the Board concludes that new approaches to the management and coordination of U.S. international science and engineering activities are needed if the United States is to maintain the long-term vitality of its science and engineering enterprise and the vitality of its economy. The Board recommends that the Federal Government (1) increase the effectiveness of its coordination of international science and engineering activities, (2) increase international cooperation in fundamental research and education, particularly with developing countries and by younger scientists and engineers; and (3) improve the use of science and engineering information in foreign policy deliberations and in dealing with global issues and problems.

U.S. Science and Engineering Infrastructure

An area of constant concern for NSF and the Board is the quality and adequacy of infrastructure to enable scientific discoveries in the future. The rapidly changing environment of new knowledge, new tools, and new information capabilities has created a demand for more complex and more costly facilities for scientific research.

A Board task force is assessing the current status, changing needs, and strategies needed to ensure that the Nation will have the infrastructure to sustain cutting-edge science and engineering research. We expect to receive the task force's preliminary findings this summer.

National Workforce Policies for Science and Engineering

For U.S. leadership in science and engineering, there is no more important issue than the development of a skilled technical workforce. As a Nation, we are not at-

tracting the numbers of science and engineering students our Nation needs to sustain its leadership. Nor are we successfully tapping all our domestic resources, especially under-represented minorities and women. The pool of potential science and engineering students will increasingly reflect the growing diversity in the American workforce and society.

A Board task force on workforce policies for science and engineering is reviewing U.S. workforce needs, the role of foreign students and workers, and policy options for ensuring an adequate science and engineering workforce for the future. We anticipate receiving the task force's report by the end of this year.

Mr. Chairman, at this point I would like to close my formal remarks. I thank the Subcommittee for its long-time support of the science community, especially the National Science Foundation, and for allowing me to comment on significant national policy concerns, as well as on the Foundation's budget request.

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