



**Testimony of
Dr. Dan E. Arvizu, Chairman
National Science Board**

**Before the Subcommittee on Research
House Committee on Science, Space, and Technology
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Chairman Bucshon, Ranking Member Lipinksi, and members of the Subcommittee, I appreciate the opportunity to speak with you today in support of the National Science Foundation's budget request for FY 2014. I am Dan Arvizu, Chairman of the National Science Board and Director and Chief Executive of the Department of Energy's National Renewable Energy Laboratory.

Before beginning my testimony, I would like to take a moment to comment on the recent leadership transition at NSF. Dr. Subra Suresh provided extraordinary vision and leadership during his tenure as Director, notably with his engagement and collaboration with the international community and his interest in ensuring that NSF-sponsored science results find its way more quickly into the marketplace.

Although Subra will be missed, Dr. Cora Marrett has capably managed a smooth transition and continues the strong working relationship between the Board and the NSF senior management team. I have worked closely with Cora throughout my time on the Board, and I want to express my confidence and admiration for her leadership. As you know, all agencies are facing difficult choices. Cora's long experience with and dedication to the Foundation and the collaborative relationship she has built with the Board will serve the Foundation and the Nation well during this time.

Introduction

On behalf of the National Science Board, and the science, engineering, and education communities which we represent, I'd like to thank members of the Subcommittee for your continuing support of the National Science Foundation. I realize that Members of Congress need to balance many national needs and priorities, but I have been heartened that Congress generally, and this Committee in particular, have provided long-standing support for the NSF investments in basic research and education across all fields of science and engineering. My colleagues on

the Board and I do not take your continued support for granted, and we consider our role to provide strong governance and proper stewardship of these taxpayer dollars our top priority.

For over 60 years, NSF has seeded our Nation's innovation ecosystem by funding transformative research projects across all fields of science and engineering. The knowledge and understanding from this research has served as the bedrock for innovation that has fueled significant economic growth, improved the quality of life for our citizens, and strengthened our national security.

More than any other agency, NSF helps advance the basic research that underpins long-term scientific and technological progress. With the support of Congress, NSF has always focused on funding the best science through a rigorous merit review system and by encouraging scientists and engineers. That's why many other nations are trying to emulate the NSF. Our integration with the community is also part of the reason that NSF only has about 6 percent overhead. We rely on scientists and engineers to serve on our advisory committees and on review panels.

Although returns on investments in basic research are unpredictable, and may not be realized for decades, this research produces the discoveries that feed into private sector innovations. Over 60 percent of Research and Development or R&D in the U.S. is funded by the business sector, but businesses naturally focus most of their investments on development or applied research, with only about 5 percent going towards basic research. Here the Federal Government plays a critical, complementary role, accounting for more than half of all U.S. basic research funding. Within the U.S. science and engineering enterprise, basic research is the “seed corn” for technological application, development, and future innovation, creating a transformative knowledge base upon which the private sector and others can draw.

Though it provides the majority of our Nation's R&D funding, private sector investment can be volatile: following the two most recent recessions R&D investment by businesses has declined. Indeed, following the latest recession, total U.S. R&D spending declined in 2009 for only the second time since 1953, primarily due to the drop in business R&D. Businesses also shifted their investments away from early stage, higher-risk research. This underscores the vital importance of strong, sustained, and predictable Federal support for R&D, particularly the basic research that the private sector is unlikely to fund.

Within the business sector, knowledge- and technology-intensive—or KTI—industries are particularly important. Globally, these industries produce about 30 percent of world GDP. In the U.S., commercial KTI industries comprise one quarter of U.S. GDP and fund three quarters of US business R&D. They employ about 20 million U.S. workers in high paying jobs, and KTI industries report a higher rate of innovation compared to other industries. Although the U.S. is the world leader in share of global value added output, our share is declining as global competition increases. For example, in 1998, China's share of value added output in the high-technology manufacturing sector was 3 percent; in 2010 it increased to 19 percent. As other countries grow their R&D capacity by making strategic investments in areas such as R&D

infrastructure and higher education, America must not only keep pace, but we must reaffirm our commitment to remain the global leader.

The U.S. science and engineering (S&E) enterprise - and our Nation's global competitiveness - rely on the combined health of all its components. When businesses scale back investments during economic downturns, if Federal Government support is unpredictable or declines or our human capital needs are not met through a robust education system, then the whole enterprise suffers with reverberations that stretch well into the future. Our Nation has benefited from the foresight of policymakers and the public in recognizing the long-term value of basic S&E research, and I again thank you for your recognition and support for this key element of our Nation's investment portfolio.

FY 2014 Budget Request

The National Science Foundation's FY 2014 Budget Request reflects a strategic commitment to supporting the best basic research that leads to economic growth, job creation through emerging technologies, and a globally competitive science and engineering workforce. The Request totals \$7.625 billion, an increase of \$592.69 million over the FY 2012 enacted levels. It is the result of rigorous prioritization of activities across the Foundation, and contains almost \$40 million in specific cuts, consolidations, and reductions. This request includes support for research in the social, behavioral, and economic sciences, which the Board endorses as necessary to fulfill NSF's mission to advance the national health, prosperity, and welfare, and to secure the national defense. The requested increase for the Social, Behavioral and Economic Sciences Directorate is \$18 million, or 7.1 percent. The Board fully endorses this Request to ensure that basic research and solutions to societal issues build upon the best multidisciplinary science.

The agency and Administration priorities in this proposal reflect a clear commitment to investments that will strengthen our economy over the long-term. I will point out that the vast majority of the proposed increases are in the Research and Related Activities (R&RA) account, which is necessary and appropriate given decreases in private sector R&D and industry's continuing shift toward development. I would particularly highlight investments in "Big Data," cyberinfrastructure, cybersecurity, clean energy, and advanced materials and manufacturing as programs that I believe will bolster long-term economic growth.

I will also highlight the Foundation's Agency Operations and Award Management account, also known as the AOAM account. This account covers NSF's scientific, professional, and administrative workforce; the physical and technological infrastructure necessary for a productive, safe and secure work environment; and the essential business operations critical to managing NSF's administrative processes and providing high-quality customer service. The proposed increase of \$3 million, or 1 percent, would give NSF support to process the 53,000 proposals we project for FY 2014, up from 48,600 in FY 2012. To sustain the Foundation's

excellent management of taxpayer dollars, the Board urges full funding for NSF's AOAM account.

For the National Science Board, we are requesting \$4.47 million, an increase of \$30,000 or 0.7 percent, which will allow the Board to meet its responsibility to oversee the Foundation's performance and fiscal integrity and to work with the Director to ensure that NSF capitalizes on the opportunities continually arising from the expanding frontiers of scientific knowledge. The Board also works with the agency's Office of the Inspector General to ensure American taxpayers receive the best scientific research in the Nation in return for their investments.

Science, Technology, Engineering, and Math Education

Education that ensures a strong future Science, Technology, Engineering and Mathematics (STEM) workforce is core to the mission of NSF, and this budget request reflects this priority. This budget will enable NSF programs to fund basic research to inform future effective curriculum and instructional practices. It will also enable significant efforts to deploy and evaluate evidence-based STEM education innovations through the new CAUSE program (Catalyzing Advances in Undergraduate STEM Education). At this point, the national dialogue on STEM education at all levels is focusing on the desire to find and deploy the best evidence-based approaches. NSF research is pivotal to these aspirations. The Board strongly urges continued support for research at NSF and for Education and Human Resources at NSF, to enable the Foundation to continue and improve upon this linchpin role.

In the past year, the Board has engaged with the Foundation's efforts to fully integrate its education mission across the agency and to ensure that science across the Foundation is used to enhance STEM education. All directorates, not just the Directorate for Education and Human Resources, are engaged and devoting attention and resources to STEM education in many ways, including involving them in cutting edge research fields through Research Experiences for Undergraduates (REU) sites, as recommended by PCAST's *Engage to Excel* report, and involving students as assistants and collaborators in almost every research project undertaken.

At the graduate level, NSF's well-regarded Graduate Research Fellowships (GRFs) continue to support the best young minds in the Nation to embark on science careers. The Board is pleased that the GRF program was expanded this year to include competitive international travel allowances for GRF recipients to undertake research collaborations with scientists abroad. As science rapidly globalizes, these new Graduate Research Opportunities Worldwide (GROW) will ensure that our next generation of scientists is involved, connected and in the lead. The proposed new budget will enable NSF to *further* expand and extend its GRFs and other traineeship awards to ensure an even stronger future scientific workforce.

Major Multi-User Facilities

Two areas in this budget proposal deserve special mention in my testimony because they have been the subject of considerable Board time and attention.

The first is the U.S. Antarctic Program, known as the USAP. The Foundation's responsibilities in Antarctica go far beyond its traditional mission of supporting ground-breaking research, and the logistical challenges of operating in the extremes of Antarctic cold demand special oversight. Last year, the Foundation, in conjunction with the White House, and with the support of the Board, undertook a thorough external review of research priorities and Antarctic infrastructure and logistics.

I accompanied Dr. Suresh in November, when he took part in a full committee hearing on the resulting "Blue Ribbon Panel" report on *Achieving Fiscal and Logistical Efficiency While Supporting Sound Science*. The Board, through its Committee on Programs and Plans, has carefully monitored the progress of both the review and NSF's response. I am pleased to report that significant steps toward implementing suggested recommendations have been taken, and that the Board has formally endorsed the Foundation's official response to this review.

This budget request will help the Foundation and the Board continue to seek efficiencies in the Antarctic and to pursue creative approaches to meeting USAP infrastructure needs. In addition to streamlining operations, the \$22 million requested would help NSF plan and execute more effective observational approaches to Antarctic science.

The second area that has commanded special Board attention during the past few years is the NSF portfolio of large facilities. The FY 2014 request seeks funding to continue construction of four Major Research Equipment and Facilities Construction (MREFC) projects and to begin construction of the Large Synoptic Survey Telescope (LSST). The requested amount reflects a slight increase over last year's MREFC funding level. I would note that predictable funding levels in this account are critical to keeping these projects on budget.

I assure the Subcommittee that the Board conducts careful reviews of facilities. Although each and every one of these projects has grown out of a lengthy science-driven prioritization process, and includes the Foundation's internal review boards, Large Facilities Office, and MREFC Panel which scrutinizes plans and budgets every step of the way, approval of these projects ultimately comes from the Board. The Board assessed and approved the LSST proposal almost a year ago, prior to its inclusion in this budget request. We review each large award that goes to construct or operate these facilities, and we spend considerable time evaluating the facilities portfolio as a whole. In fact, we have a subcommittee of the Board devoted entirely to assessing and reviewing our facilities and the Foundation's governing processes.

The Board has been responsible for advancing our current policy to recompute management of long-lived facilities, and has been working with the Foundation to ensure that NSF's investments

in facilities are balanced with our mission to advance the progress of science. And the Board is not alone in rigorously reviewing these large - but critical - investments. The Director's Office has recently completed its own comprehensive review of large research facilities, and has identified a number of actions that address specific Inspector General concerns and will help NSF improve planning and oversight for large facilities.

I would be remiss if I did not mention one particularly impressive example of NSF's determination to responsibly manage its facilities portfolio. The Astronomy community has worked with NSF on a comprehensive review of its existing facilities and scientific priorities. This review resulted in recommendations to divest some highly-successful, long-running facilities. The Board only felt comfortable including LSST in this year's budget request because the Astronomy Division and community have embraced this kind of strategic, responsible planning.

Selected National Science Board Activities

As part of NSF's policy-setting process and in its role as an advisor to Congress and the President on science and engineering issues, the Board identifies important or emerging topics for detailed examination. Many of these are identified through our work on the statutorily mandated biennial *Science and Engineering Indicators* report to Congress and the President. I would like to briefly mention three of our recent and ongoing inquiries.

Science and Engineering Indicators

As you know, our Nation's research universities are the best in the world and are vital to the U.S. S&E enterprise. Several years ago, the Board identified a new concern about declines in state funding for our flagship public research universities. These universities produce a large share of our undergraduate and graduate degree holders. Research universities are particularly important because they provide students with access to an affordable, quality education and opportunities for world-class research experiences. Many states also expect them to produce local and regional economic benefits by seeding new startups and providing local businesses access to highly skilled graduates.

The Board's response to these trends was two-fold: First, we included additional reliable, policy-neutral data and trends for these universities in the 2012 edition of *Science and Engineering Indicators*. We plan to enhance our coverage of this topic in future editions of *Indicators* as new data become available to provide you and other interested stakeholders with the best available information on these vital institutions.

Second, we explored these trends and their implications further in our 2012 policy companion report to *Indicators*, entitled *Diminishing Funding and Rising Expectations: Trends and*

Challenges for Public Research Universities. This report examined the health and competitiveness of our flagship public research universities, highlighting the 20 percent decline nationally over the past decade in per student state funding and the additional challenges posed by rising enrollment and costs. Given that these data are particularly relevant to state-level policymakers, in addition to the national data, we provided state-by-state funding and enrollment data for the past 20 years.

Administrative Burdens

In 2009 Congress requested that the National Academies provide a follow-up report to *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* that would more closely examine the health and competitiveness of the nation's research universities. Among the findings of the 2012 follow-up report, *Research Universities and the Future of America: Ten Breakthrough Actions Vital to Our Nation's Prosperity and Security*, was that "the problem of excessive regulatory burdens ... puts a drag on the efficiency of all university research" - potentially costing "billions of dollars over the next decade." The report recommended that Federal agencies "reduce or eliminate regulations that increase administrative costs, impede research productivity, and deflect creative energy without substantially improving the research environment," and that they harmonize regulations and reporting requirements across agencies.

Congress, in response to the NRC report, held hearings last June. Among the challenges noted by representatives from the Nation's research universities testifying at the hearing were the "increasing numbers and complexity of Federal regulations" that "consume increasing amounts of time and money." In October, Representative Mo Brooks, former Chairman of this subcommittee, requested that the Government Accountability Office conduct a review of current regulations and reporting requirements imposed on research universities.

The Board shares the concern that some administrative tasks may unnecessarily be consuming taxpayer dollars and time that our nation's scientists, engineers, and educators could otherwise devote to the federally sponsored research. Many of our members have experienced, over their careers, increasing requirements as both researchers and administrators. We are also aware of the impact administrative compliance has on NSF's program officers. As a result, the Board created a Task Force on Administrative Burdens in December, and charged it with assessing current requirements on Federally-supported researchers, and offering recommendations where appropriate on relieving the administrative workload. We are mindful that many requirements have been created for proper stewardship, and we hope that this effort, particularly as a complement to ongoing initiatives from the Office of Management and Budget, will help make the Federal research enterprise more efficient and productive.

The Task Force will produce a report of its findings and actionable items for reducing administrative work associated with Federal awards thus increasing efficiency and time spent on research later this year.

Merit Review

Another priority for the Board has been oversight of the Foundation's Merit Review Criteria. The two Criteria, "Intellectual Merit" and "Broader Impacts" are the backbone of the Foundation, shaping the peer review process so that NSF funds the highest quality projects, those with the potential to advance, if not transform, the frontiers of knowledge and which have the potential to benefit advance societal goals broadly.

As you know, the final FY 13 Continuing Resolution restricted what NSF could fund in political science. The NSF and the National Science Board will fully comply with the law, however we would like to raise concerns about how these strictures can undermine the merit review process and the progress of science. While we understand that it is Congress's responsibility to set spending priorities, the Board believes that legislatively imposing restrictions on a class of research will not serve the national interest.

The National Science Board and NSF's merit review policies, which are lauded and emulated internationally, recognize that it is crucial to be open to receive the best scientific ideas, to have those ideas judged by experts who can assess the soundness and promise of what is proposed, and to make decisions based on potential scientific and societal value. To cut whole classes of science from consideration can have significant unanticipated consequences. For example, when NSF funded Elinor Ostrom's work on common property, it was not anticipated that her findings would challenge the conventional wisdom that common property is poorly managed and should be regulated or that this Political Scientist would win the Nobel Prize in Economics.

At the end of 2011, building on Congressional direction in the *America COMPETES Reauthorization Act of 2010* and substantial community input, the NSB Task Force on Merit Review delivered its report, *NSF's Merit Review Criteria: Review and Revisions*. This report reiterated NSB's commitment to the principle that all NSF projects should be of the highest quality and have the potential to advance the frontiers of knowledge, and to the concept that, in the aggregate, NSF projects should advance societal goals.

Although the report recommended that the two Merit Review Criteria remain Intellectual Merit and Broader Impacts, it attempted to define more clearly the two Criteria to help the NSF community better understand each and how they interrelate. During the past year, the Foundation developed specific policies based on the NSB guidance, and they were implemented on January 14th of this year.

The Board also has a longstanding policy of requesting that the NSF Director submit an annual report on the NSF merit review process. This report gives NSB a long-term perspective on the merit-based awards that allow NSF to achieve its unique mission, and we consider it an important tool for ensuring the health of the Foundation. I want to share a few key observations from the last report, which is based on FY 2011 data. First, as I mentioned before, the number of proposals received by NSF has increased over 60 percent in the past decade, and now surpasses 50,000 per year. Despite this increase, the Foundation still replies to over 70 percent (78 percent in FY 2011) of proposals within 6 months of receipt, exceeding our goal.

But the increased numbers of proposals has caused a persistently declining funding rate. In FY 2011, 22 percent of proposals were funded, and in FY 2012, as detailed in this budget proposal, the Foundation estimates that this will fall to 21 percent. In some Divisions it is significantly lower. Although the *American Recovery and Reinvestment Act* resulted in increased funding rates in FY 2009 and 2010, a long-term decline has since resumed. The Board is concerned that these declining success rates may discourage promising researchers from bringing high-risk / high-reward proposals to NSF or even from pursuing a career in science or engineering.

Conclusion

In closing, Mr. Chairman, I would like to again thank the Subcommittee Members for your continued leadership on science and engineering issues and for your support for NSF. The National Science Board recognizes the fiscal realities that you are confronting, and we pledge to work closely with the Director to set priorities and make the sometimes difficult decisions required to obtain the best return on the taxpayers' investment.

Even in a time of severe constraints, the Board believes that productive spending in support of innovation contributes to the economy and the creation of jobs in the United States. The Foundation's long history of expanding the frontiers of knowledge has paid enormous dividends over the past several decades. Our global competitors are increasing their commitments to basic research and STEM education, and we believe that preserving the Foundation's role in supporting these areas is critical.

As you weigh competing priorities, the Board hopes that you will keep in mind how investments in our national science and technology capabilities - including our S&E workforce - are essential to our Nation's long-term prosperity and security. The Board supports the President's FY 2014 Budget Request for the National Science Foundation because we believe, over the long-term, that these investments will lead to economic growth and an ever-improving quality of life for our country.

Thank you for the opportunity to testify.