**Testimony of Dr. Catherine T. Hunt**
**President of the American Chemical Society**

**to the**

**U.S House of Representatives**
**Committee on Science and Technology**
**Subcommittee on Research and Science Education**

**March 29, 2007**

## Introduction

Chairman Baird, Ranking Member Ehlers, and distinguished members of the Subcommittee:

Good afternoon.

As president of the American Chemical Society, or ACS, it is my great pleasure to address the Committee on behalf of our more than 160,000 members as you consider reauthorization of the National Science Foundation (NSF).

Our Society was congressionally chartered in 1937 to advance chemistry in all its branches, promote scientific research and inquiry, and foster public welfare and education. We have long been strong supporters of the National Science Foundation, an agency of particular importance at this critical time in our nation's history.

As the members of this committee are keenly aware, the United States faces threats to its economic and technological leadership from countries that have made monumental investments in educating their workforces as well as investing in research and development – thus becoming emerging and growing innovation incubators – with the result that they are capitalizing on international economic and intellectual investment.

Our heretofore unmatched capacity to innovate—to create new products and processes, markets, and industries that change the world—depends on three critical and interdependent elements:

- Novel new ideas that flow from a strong, diverse, basic research enterprise;
- A creative, well-trained, and determined workforce; and
- An environment that not only fosters, but facilitates, an innovation pipeline that moves ideas from conceptualization, to invention to market.

The NSF is unique amongst federal research agencies in that it broadly supports science and engineering--across all disciplines. The history of this unique mission is instructive to our consideration about the future of the agency. NSF grew out of the international and global challenges of the mid 20$^{th}$ century.

Allow me to quote from *NSF: A Brief History*, a 1994 report that detailed the formation and history of the Foundation:

> *President Truman signed the bill creating the National Science Foundation on May 10, 1950. The act provided for a National Science Board of twenty-four part-time members and a Director as chief executive officer, all appointed by the president. Among other things, the law directed the agency to encourage and develop a national policy for the promotion of basic research and education in the mathematical, physical, medical, biological, engineering, and other sciences; to initiate and support basic scientific research in the sciences; and to evaluate the scientific research programs undertaken by agencies of the federal government. Organizationally, the Foundation could create whatever divisions were necessary to carry out its activities, but the act specified that four divisions had to be included: medical research; mathematical, physical, and engineering sciences; biological sciences; and scientific personnel and education. The latter division was responsible for scholarships and graduate fellowships.*

It took five years of debate between Congress, the Truman administration, and the scientific community to establish an agency that truly supports the scientific enterprise in the United States by focusing concurrently on broad support for research and university science and for science education. NSF and its unique mission are equally relevant today as the agency plays a central role in our national response to the innovation challenges of the 21st Century.

NSF provides about one-fifth of all federal funding in support of basic research at America's colleges and universities. The Foundation also plays an absolutely essential role in addressing challenges in the area of science, technology, engineering, and mathematics (or "STEM") education from kindergarten through graduate school and beyond.

The NSF has also been charged with the highly important and extremely challenging mission of promoting science on a broad basis and bridging the gulf between scientific advances and public understanding.

A hardworking and entrepreneurial American workforce, coupled with aggressive federal and private investment in scientific and technological research has achieved such notable milestones as sending a man to the moon, harnessing the atom and sequencing the human genome. These achievements, as well as reams of other examples, have long supported the economic underpinnings of the U.S. economy that is the envy of the world.

But our future economic leadership is not something we can take for granted. As the much quoted National Academies *Gathering Storm* report warns, we need to redouble our efforts to revitalize our science, technology, engineering and mathematics (STEM) education system to generate future innovators, while at the same time making a parallel investment in our federal research and development capabilities to serve as the incubator to bring new ideas and innovations to fruition.

Education and research and development go hand-in-hand as among the most important pillars of American innovation that can sustain our global competitiveness.

NSF has a vitally important role to play in both education and research and development, especially in the years ahead as we rise to meet the unprecedented threats to our global economic strength and competitiveness. With these grand challenges in mind, I welcome this chance to offer our Society's observations on a few of the key opportunities that NSF can pursue to achieve its overall goals during the next five years.

**Cultivating Young Investigators**

I turn first to the question of how NSF might take a more active role in developing our future scientific excellence by supporting young investigators —our nation's future innovators.

We applaud the Committee for taking action last month to advance legislation related to this specific topic. The "Sowing the Seeds through Science and Engineering Research Act", HR 363, would strengthen the NSF CAREER grant program by tying CAREER grant funding to the overall NSF budget – so that as NSF grows, so will its commitment to support young investigators – and also by helping universities better identify and target the needs of young investigators.

It has never been a great secret that young minds with fresh ideas are essential to advancing our understanding of science, so it is of paramount importance that we ensure that new investigators have good opportunities to compete for funding to enable them to establish their research programs in academe and elsewhere.

We have long supported efforts by the Committee and others to expand the NSF CAREER grant program, which targets resources for young investigators. CAREER grants are clearly one of the best mechanisms for giving young investigators a chance to compete against their peers for vital early support funding.

Unfortunately, as the overall research budget for the physical sciences and NSF in particular has been effectively flat over the last several years – at least until very recently – it has forced an unfortunate competition between more established researchers and new young investigators for grants, with the result that many new investigators are finding it often difficult – and sometimes impossible – to the find the funding necessary to establish innovative research programs of their own.

One reason that the American Chemical Society has strongly supported the American Competitiveness Initiative and other efforts that recognize the critical link between support for basic scientific research activities and our future economic competitiveness is that by increasing the size of the grant pool for research in general, we avoid – pardon the analogy – robbing "Peter" to pay "Paul."

In reality we need to support both "Peter" and "Paul" if we intend for our country to keep producing the tremendous array of innovations that will keep our economy growing in the decades to come.

We have also come to understand that while most young investigators are equipped with cutting edge technical and research skills, they are often poorly prepared for their teaching responsibilities and frequently ill-equipped to deal with the "non-research" tasks that they must take on, including grant writing and other essential academic endeavors.

One project supported by the American Chemical Society in this area is the Preparing Future Faculty (PFF) Program, which was started in 1993 as a partnership between the Council of Graduate Schools and the Association of American Colleges and Universities (AAC&U) and funded in part through an NSF grant.

The PFF program, which now reaches more than 300 partner colleges and universities, has helped increase our understanding of the expectations of new faculty with regard to teaching, research, and university service are often at odds with the skills that doctoral graduates have developed during their two decades of educational experience. Several years ago, the original PFF partners teamed up with the American Chemical Society and other professional societies to participate in an NSF funded extension of PFF to create a "Shaping the Preparation of Future Science and Mathematics Faculty" program at five universities across the country. This latest project brings large research universities and smaller colleges into partnerships that provide an environment for graduate students to learn about the full range of faculty roles and responsibilities in teaching, research and service.

What we are hoping to achieve is a better understanding of how to prepare future faculty in the inter-related chemistry, physics, mathematics, and computer science fields to be successful researchers. We encourage NSF to continue to support projects like this that deal with the "human capital" side of the young investigator equation.

But well prepared new faculty will not help power the engine of American innovation without the means to bring their creative ideas into reality – and for this we must address the funding side of the equation as I have emphasized already.

## Improving K-12 STEM Education

I would like to touch now on NSF's role in fostering improvements in STEM education at the K-12 and university level.

Let me state clearly that NSF must recognize that its educational mission is every bit as important to the nation's future as its research mission.

We must set aside any notion that NSF's education programs are either subservient to or stand in competition with its research programs. NSF's education and research missions are mutually supportive, and play key, unique roles in building our nation's scientific and technological capacity.

Last year, we supported a provision in the Senate's broad competitiveness package that would require funding increases in NSF's Education and Human Resources (EHR) Directorate that are proportional to the overall increase in the Foundation's budget, so that as NSF's resources grow under the proposed American Competitiveness Initiative, research and education will grow together.

It is our understanding that the Committee is contemplating a similar provision while reauthorizing NSF's undergraduate education programs, a step that our Society enthusiastically supports.

One way that the American Chemical Society promotes excellence in chemistry education for undergraduate students is through our approval of college and university chemistry programs. Graduates from ACS-certified programs must often complete requirements that exceed those of the degree-granting institution. The certified degree program establishes that the student has completed an integrated, rigorous program that includes laboratory experience and the development of the professional skills needed to be an effective chemist. In addition to the direct benefits to students, the university program approval process provides a mechanism for departments to evaluate their program, identify areas of strength and opportunities for change, and leverage support from their institutions and external agencies.

Given the tremendous complexity of the educational challenges our country faces, I cannot emphasize strongly enough that NSF is uniquely situated as the agency best-suited to bridge the distance between the scientific and education communities. If, in responding to the math and science challenge our nation faces, we do not take full advantage of the unique strengths of NSF, we will be making a mistake.

There are many government agencies that play vital roles in math and science education, but the National Science Foundation should play the lead role. There is little doubt that NSF is one of the premier research institutions in the world, or that maintaining this position is a point of pride for the Foundation. I think it should also proudly hold the title of being the world's leader in educational innovation, helping future scientists more effectively deliver scientific knowledge to eager young minds.

In order to achieve this, we must expand our research efforts in science and math education. We need new technologies, new curricula, new resources and content materials, and most of all, new thinking on this subject. In other words, we need to leverage what NSF does best – expand our knowledge base by funding the best possible educational research. The nation has an ongoing need for research and innovation in math and science education, because, as we extend scientific and mathematical knowledge, develop new instructional technologies and uncover more about human learning, we must apply this new information to improve student learning.

Creating the world's best classrooms, teacher preparation programs and science learning methods is going to require a structured, focused research effort on a fairly large scale. We do not know what will work best in every U.S. classroom.

Education, in general, and math and science education in particular, is a very complex undertaking involving a large number of variables. Therefore, we need to do what this country does so well: assemble a world-class research effort at NSF with the resources necessary to produce real progress in an area of national importance.

NSF must clearly be the lead agency in undertaking this crucial research task.

**On Interdisciplinary Research**

I would now like to address the subject of interdisciplinary research. Let me start by pointing out something that is obvious among chemists, but may be less so outside of our discipline: The field of chemistry has dramatically changed – and it is still changing.

An increasing number of chemists now work in areas that previously were beyond our normal scope and might not have even been considered chemistry as little as a decade ago. The rapid science and technology advances of the last few years have not only opened new arenas, but the boundaries between traditional disciplines have blurred. This presents new challenges to research agencies that are tasked to identify and support the best science – which has traditionally been found along clear disciplinary lines.

Today's studies are leading to new fundamental discoveries and an expansion of the boundaries of molecular science that has given way to a bewildering increase in the need to comprehend and integrate information and techniques across diverse disciplines.

A theme we emphasize at the American Chemical Society is that chemistry is an "enabling science" – the idea that breakthroughs in chemistry underpin many of the advances we see in other fields. Faster computers, the explosion of nanotechnology and batteries for hybrid cars are prominent examples of this.

To quote former National Institutes of Health (NIH) Director and Nobel Laureate Harold Varmus: "Medical advances may seem like wizardry. But pull back the curtain, and sitting at the lever is a high-energy physicist, a combinatorial chemist, or an engineer."

Thus, the grand challenges of today—energy, food, water, security, health care – are interrelated and interdependent. These challenges will require strong collaborations between scientists and engineers in universities, industry, and national laboratories – and they will require us to focus on sustainable solutions. However, this emerging collaborative, interdisciplinary and sustainability paradigm for scientific endeavors is still relatively new.

In 2005, our Society conducted a comprehensive survey of its members that identified "continuing education in emerging and interdisciplinary fields" and "programs to encourage greater collaboration among chemists internationally; across disciplines; and across industrial, academic, and government" as two high priorities from a diverse list of more than 13 different proposed new initiatives. These subjects barely registered in a similar 2001 survey.

As the importance of such interdisciplinary research continues to increase, the scientific grant system must adapt to this new paradigm.

The challenge of the federal research agencies will be in moving toward a grant structure that maximizes scientific advances by supporting interdisciplinary research. Currently this is done by establishing initiatives at the borders of disciplines, which provides a new set of limitations to replace the traditional disciplinary boundaries.

The most effective way to support basic research, particularly in chemistry, is the individual-investigator or small-team grant. Any solution to the challenge of promoting interdisciplinarity must preserve the strength of that mechanism, which traditionally has considered and awarded grants along disciplinary lines. This will require a long-term concerted effort and considerable patience.

We encourage NSF to watch the NIH experiment to award grants to a small number of co-equal principal investigators. This will likely have the effect of encouraging both collaboration and interdisciplinary cooperation.

NSF doesn't necessarily need to create a profusion of new programs to deal with this particular aspect of the research enterprise. One avenue of progress could be to make a concerted effort to identify ways to broaden the backgrounds of the members of NSF's various review panels and study sections and also the appropriate program officers to include more individuals with experience, enthusiasm, and new ideas for approaching interdisciplinary research.

One activity that the American Chemical Society has undertaken to promote interdisciplinary research in this area has been to support the Bridging the Sciences Coalition, a group of more than a dozen scientific societies and pharmaceutical companies – representing over 250,000 scientists – that is focused on supporting deep innovation in physics, chemistry, engineering, mathematics, and computer science – the "bridging" sciences – that must interface with biology and medicine to enable significant biomedical advances.

Without getting too much into the details, this "bridging" initiative seeks new federal resources to support research in these boundary fields as a means for pursuing distinct and unmet opportunities in the biomedical sciences.

As you would expect, starting new interdisciplinary research initiatives begins by clearly articulating the nature of the new research opportunity, the potential for new discoveries, and the tools and resources that are required.

We envision support for this "bridging science" initiative to come through a federal structure that combines the biomedical research cachet of NIH, the discipline-driven breadth of NSF, and the physical science depth of the Department of Energy – and we have met with progress on this front during the recent NIH reauthorization process.

While undertaking such broad collaborative efforts to bring together a productive partnership across agencies can be challenging, this is the kind of effort we need if we are to truly improve

our capacity to capture the value that is inherent in interdisciplinary research NSF is ideally suited to promoting cross-disciplinary research because, as I mentioned before, the Foundation already supports science and engineering broadly, across all disciplines.

Along these same lines, the Committee reported legislation in the last Congress that would authorize the NSF to "establish a program to award grants for long-term, potentially path-breaking, basic research designed to simultaneously advance the physical and non-biomedical life sciences" – a provision that we supported.

On the administrative side, the Foundation has established several interdisciplinary project offices within its divisions and directorates. We note that the FY2008 budget proposal for NSF would support the creation of a new, multidisciplinary center for environmental, health, and safety research – a development we encourage.

The Committee has done an excellent job in the past to ensure that NSF has the flexibility to make alterations in its administrative organization to deal with the evolving nature of science – and the American Chemical Society encourages you to continue to empower NSF with the the tools and flexibility necessary to allow it to fulfill this aspect of its important national mission.

At the end of the day, it is clear that as NSF continues to grow through the American Competitiveness Initiative and the strong support of the members of the Committee, the Foundation's role in supporting interdisciplinary research must also expand and that the agency must adjust its institutions and structure to deal with the changing nature of scientific research.

**Encouraging Industry Partnerships**

The final topic I would like to speak to is that of how NSF might better leverage its partnerships with business and industry.

When I am not serving in my role as president of the American Chemical Society, my day job is as Leader for technology partnerships at Rohm and Haas Company, where I focus on building collaborations across companies, academia, government agencies, and private foundations.

In the corporate environment, the financial decision-making structure places a great premium on research that will yield results in the shortest possible time frame. So the vast majority of industry funded research is of the applied variety, typically focused on ideas that have potential for near term commercialization.

However, as this recent national debate on innovation and competitiveness has so clearly demonstrated, basic research in the physical sciences is one of the true engines that drives the long-term prosperity of our economy if it can be converted into the new products and industries that revolutionize our world.

Since NSF and other federal research agencies are the primary sources of basic research funding, it makes good sense for industry to partner in a symbiotic way with the agencies and their

university grantees to collaborate on projects that can benefit from combining expertise from both the "applied" and "basic" sides of the research "house".

We understand that the Committee is considering a change to NSF's merit review criteria that would give special consideration to proposals that include partnerships between academic researchers and industrial scientists and engineers and that address research areas that have been identified as having high importance for future national economic competitiveness.

The ACS would support such efforts as a means to encourage more industrial collaborations through the NSF grant structure. As a final, I would also like to observe that in thinking about the question of how to support young investigators that I addressed earlier, it is also valuable to encourage new investigators to pursue collaborations and partnerships with industry – possibly as an a provision of the CAREER grant program.

## Conclusion

In conclusion, I would like to thank the Committee for the opportunity to represent the views of the American Chemical Society and the scientific community here today.

We at the American Chemical Society have been deeply engaged in the evolving debate about the future of American competitiveness that has so dramatically unfolded over the last couple of years. This "competitiveness" movement is still picking up steam and we plan to see it through to a new era where our nation's technological leadership is again confirmed and renewed.

We see the process of NSF reauthorization as a key component of this debate and we applaud the Committee for taking swift action to complete your work on this front.

Let me conclude by touching on that old cliché that history tends to repeat itself, as illustrated by something the very first President of the American Chemical Society said at a time when another great technological ground shift – the Industrial Revolution – was shaking the world:

> *"Mankind has made the discovery that science is the great civilizing agent of the world. Let us continue our labor unobtrusively, conscious of the integrity of our motives, conscious of the portentous change in the thought of the world, conscious of the irresistible power that is behind us."*

Thank you.