Written Testimony of
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I submit this testimony to the Committee for inclusion in the record of the hearing entitled, *Driving Innovation through Federal Investments*. I am Michael Purdy, Executive Vice President for Research at Columbia University and I begin by thanking this Committee for its long-standing, steadfast support for the nation's research enterprise.

At the outset, I would like to respectfully suggest that despite the budgetary constraints facing this Congress, ***the legislation this Committee will produce this year should send a clear and unmistakable message to our international competitors that this Nation is committed to making the investments necessary to keep us at the leading edge of the global knowledge economy.***

Think back to the day Hurricane Sandy slammed into the eastern seaboard. Now that the storm has come and gone – and we continue our efforts to recover from its impact -- consider what would have been the impact of Sandy on the mid-Atlantic region of this country if the storm had hit in October 1963 – 50 years ago. The short answer is that the loss of life could have been in the tens of thousands.

Fifty years ago, hurricane advisories extended only two days into the future, computer models and weather satellites were in their infancy, and forecasters might not have expected Sandy's late westward curve into New Jersey. We did not have the sophisticated weather information system that made it possible for the nation's weather enterprise to make the call on Sandy as early, as often, and as accurately as was done, so that residents and businesses had sufficient warning to prepare and take shelter. While still not perfect, these modern forecasts undoubtedly made a life or death difference for many, many people.

How did we acquire the ability to make such a forecast? We – society – continuously invested over decades in science, technology, engineering, mathematics, and education. These investments supported everything from basic research in mathematics and computer science to the development of satellites and parachute-borne instrument packages that could make the key observations. They enabled us to develop and run forecast models on advanced computing systems so that the large amounts of data could be turned into "actionable intelligence". Finally, through investments in education, they helped create the talented human capital base needed to put it all together.

We are, in some ways, more vulnerable to severe storms today than we were in 1963. We now have many more people living in coastal areas. We are highly dependent on communication systems that can be disrupted by powerful storms. We are also dependent on the power grid for everything from transportation to commerce to sophisticated medical care.

But it was not just the investment in the physical and mathematical sciences or satellite technology that delivered this life-saving information. It was also our investment in interdisciplinary environmental sciences – including weather, climate, ocean and coastal research – as well as the social, behavioral and economic sciences that examine how people use storm-related information and respond to warnings – the human factors. Together, this knowledge enabled state and local emergency managers and first responders to prepare and inform citizens in ways that saved lives and property. And it was a host of

innovative technologies that allowed all of this information to be presented in a manner that most people could understand.

The Sandy example is just one of many such stories that can speak directly to how investments in research and education have supported the economic and national security of the United States and its people. The Nation owes a debt of gratitude to this Committee and the Congress for appropriating the resources over time that has led us to this point. The next round of funding decisions this Committee will soon make offer the Nation the opportunity to continue this incredible – and to our competitors, *enviable* - story of success and to shape an even more vibrant, accountable, and transparent research enterprise for the future, all serving the national interest.

Recent reports, however, have shown our nation's role as the world's innovation leader is imperiled. The combination of eroding federal buying power in research and higher education and the enormous resources other nations are pouring into these areas is creating a new kind of deficit for the United States: one that has been called an *innovation deficit*. It is troubling that the U.S. has fallen to 12th among developed countries in the share of young adults who hold college degrees. Closing this widening gap between needed and actual investments, while ensuring the health and vitality of the research enterprise, must be a national imperative.

If we fail to act boldly - in the united and determined fashion of the past - the result will be a less prepared, less highly skilled U.S. workforce, fewer U.S.-based scientific and technological breakthroughs, fewer U.S.-based patents, and fewer U.S. start-ups, products, and jobs. These impacts may not be immediately obvious because the education and research that lead to advances do not happen overnight. But the consequences are inevitable if we do not respond to this innovation deficit.

The path for resolving the budget challenges facing the nation is undeniably complicated. However, a central component of whatever answer we reach must include true sustained growth of the federal investment in research and education that will bolster our nation's economic and national security for decades to come. Such growth will allow for fundamental new knowledge to be discovered – here, by us, in the United States. It will allow for brilliant young scientists and engineers to contribute and innovate, and will, as in the past, enable economically significant, but often unanticipated, advances to occur. Research and education should be seen as an *investment* with returns of incalculable value in terms of economic prosperity, quality education, national security, and international standing and competitiveness.

The justification for this view is rooted in past success. More than half of the national economic growth since World War II has been a consequence of technological innovation, overwhelmingly resulting from federally funded scientific research. Such groundbreaking research has led to life-saving vaccines and medical devices, lasers, MRI, touchscreens, GPS, the Internet, and accurate life-saving predictions of severe storms. These and other advances have improved lives and generated entirely new sectors of our economy.

The competition we face in the coming decades is real. Having witnessed this nation's success at turning investments in research and higher education into innovation and economic growth, countries such as China, Singapore, India, and South Korea have dramatically increased their own investments in these areas. Over the past decade these other nations' investments have climbed at two to four times the rate of growth in our research and development expenditures. With these challenges in mind, I would like to suggest that the Committee consider the following set of principles or guidelines for the appropriations bills soon to emerge from this Committee.

Principles for the Funding of Science and Engineering

The National Academies' report, *Rising Above the Gathering Storm*, and both the America COMPETES Acts of 2007 and 2010, set goals and established funding targets aimed at doubling funding for key federal research agencies within seven years. I fully recognize the difficulty of achieving the doubling goal in the current fiscal environment, but I believe that the forthcoming appropriations bills should:

- Make a strong statement that the United States sees funding across all disciplines of basic scientific and engineering research as a national priority with an appropriate balance between supporting the conduct of research and the cutting edge infrastructure needed to carry out that research;

- Set targets that provide for steady and sustained real growth in funding for all of the major federal research agencies – defense and non-defense;

- Support funding pathways for competitive programs, core research, and infrastructure that avoid detrimental tradeoffs between one field of science and another and are based on utilization of well-managed peer review mechanisms designed to assess merit and avoid real and perceived conflicts of interest.

- Maintain a strong foundation of basic research across all scientific disciplines, from the physical, mathematical, environmental, health and life sciences, to engineering, to education research and the social, economic and behavioral sciences;

- Ensure that federal scientific agencies, guided by national needs and their scientific advisory committees and boards, continue to set and articulate clear priorities for funding within and among the full range of scientific disciplines – priorities that serve the advancement of scientific knowledge and are clearly in the national interest; and

- Commit to public accountability, transparency, and excellence in all aspects of the national research and education enterprise

Principles for the Funding for Education and Workforce

The maintenance and promotion of scientific literacy to prepare our young people for 21st century jobs and citizenship, and the strengthening of the pipeline of scientists and engineers, who will propel science and innovation forward, were essential goals of the *Rising Above the Gathering Storm* Report. The improvement of our science, technology, engineering and mathematics (STEM) literacy and talent base is essential if the U.S. is to continue its scientific, technological and economic global leadership. To this end, I urge the Committee to:

- Support innovative and effective education programs to promote the broad-based scientific literacy necessary to equip all citizens with the scientific and technical knowledge required to meet future national and global challenges, as well as to train future generations of U.S. scientists and engineers;

- Support the improvement of STEM education at all levels – and at a national scale - by sustaining research critical to our understanding of how students learn STEM, how best to teach students in STEM fields, and how to increase participation of women and underrepresented minorities in STEM fields;

- Support proven STEM education programs at the federal research agencies aimed at ensuring an adequate STEM workforce in direct support of the fulfillment of their respective agency missions; and

- Support immigration reform for high-skilled workers and other policies to ensure that the United States has access to, and is fully able to take advantage of, the best and brightest talent in STEM fields from around the world.

Principles for Maintaining Research Excellence and Opportunity

The U.S. system of scientific research has been tremendously successful because it has remained broadly based and insulated from political pressures; key scientific focus areas have been determined by federal agencies, guided by the scientific community through a strong system of merit review and advisory committees; and research results have been widely distributed and made accessible. I suggest that, where appropriate, the Committee should:

- Support the "gold standard" system for research funding based upon competitive scientific merit, and broader impact, evaluated through peer review. Peer review has been a critical factor in the success of America's research system through its use of panels of scientific experts to evaluate the quality of proposals. In this competitive process, proposals compete for resources based on their scientific merit and potential for broader impacts. Peer review helps ensure that federal agencies support the best, cutting edge research; provides a self-correcting mechanism that works to help improve the quality of future research proposals; and provides public accountability by assuring that tax dollars are spent in the most effective manner.

- Preserve and support programs that seek to stimulate competitive research capabilities and opportunities in particular states and regions and for those institutions and populations currently under-represented in science and engineering; and

- Reduce or eliminate unnecessary or duplicative federal regulations and reporting requirements that increase research costs, impede research productivity, and needlessly divert researchers' time from directly conducting scientific research and mentoring students.

Concluding Thoughts

We are all aware of the serious budgetary challenges the Nation must confront. However, as the Committee grapples with these difficult issues, it is important to keep our nation on an innovation path that makes it possible for our economy to grow and our citizens to prosper. Public trust in the conduct of our scientific and educational research efforts must be gained – and retained - through appropriate accountability and transparency provisions, and - just as importantly - through a national commitment to vibrancy and excellence in the pursuit of new knowledge and in the development of human capital. Throughout our history, this nation has kept the promise of a better tomorrow to each generation. This has been possible because of our economic prosperity is based in large part on America's role as global innovation leader. Failing to respond to today's challenges with sustained strategic investments in our research and education enterprise will pass to future generations the burdens of lost leadership in innovation, possible economic decline, and significantly more limited job opportunities for our youth.

Thank you for the opportunity to submit these views.