Statement of

Ralph J. Cicerone
President
The National Academy of Sciences

before the

Subcommittee on Commerce, Justice, Science, and Related Agencies
Committee on Appropriations
U.S. House of Representatives

March 3, 2009

Good Morning Chairman Mollohan and members of the Subcommittee. I am Ralph Cicerone, President of the National Academy of Sciences, which was chartered by Congress in 1863 to advise the government on matters of science and technology. We work along with the National Academy of Engineering and the Institute of Medicine.

Thank you for the opportunity to speak with you today about the enterprise of science in the United States. It is a subject that is tremendously important to our country and complicated enough that no one knows the whole picture. Therefore, the hearing that you are holding is essential for all of us.

Current Status of American Science

The enterprise of science in America is very strong. Federal investment in American science has enabled the U.S. to be the world's scientific leader since WWII. Continuing federal investment has led to unmatched growth in prosperity through the creation of technology, and technological advances have increased the quality and span of life for Americans and for people around the world. Our science has also led to amazing discoveries about our universe and about life itself and altogether. It has also contributed greatly to the high opinion in which the United States is held in most countries. Other significant benefits include the strengthening of our military power to deter and to fight wars.

Science comes in many kinds. Your subcommittee oversees much of American physical sciences and engineering yet there is also a major enterprise in biomedical science.

American science continues to lead the world in the physical sciences but faltering federal support over the last 30 years or so, along with increased emphasis and investment elsewhere in the world, has reduced our lead. In fact, our leadership is now disputed in some fields of physical science. In fundamental biology and biomedical science including the creation and development of pharmaceuticals and biomedical instruments, the American lead is larger although not in all sub-specialties.

How can I say these things about our relative position? What measures does one use? There is no simple yardstick (meter stick) that does all of the measuring. Instead, we keep track of many variables like federal research spending, numbers of patents, numbers of research papers in top-notch scientific journals, citations to those papers, how many new Ph.D.'s are produced each year, graduate student enrollments, and Nobel Prizes and other prestigious prizes that are awarded on merit.

Actually, it is somewhat of an exaggeration to say that "we keep track" because not many people do; one of the best and only sources of information is the National Science Foundation and the National Science Board. In other countries, there is increased attention to inventorying and measuring scientific investment and productivity, especially in nations where national plans are being implemented.

Besides federal funding, what else is needed to sustain the science enterprise? Talented ambitious people are essential. The stream of such people starts with childhood education and continues through college and university years to graduate and post-

graduate education. To attract the brightest graduates, career opportunities must be available along with specialized equipment such as laboratory instruments and computers.

American science draws deeply from American-born people who study and produce here but we have also enjoyed a large advantage over other nations through the emigration of students and scientists from other countries to our shores. We received many gifted people who fled pre-WWII Europe and the Nazis, followed by others who left Iron Curtain countries and still others who sought opportunities here, from Britain, all of Europe, Japan, China, India and Africa, for example. Names like Einstein, Fermi, Bethe, von Braun, von Neuman and Kandel come to mind. In fact, 24 % of living American Nobel Prize winners were born in other countries. Similarly, of the scientists elected to membership in the National Academy of Sciences in the last ten years, 23% were foreign-born (and are now naturalized U.S. citizens). However, recognition as Nobel Laureates and as NAS members is usually for important research from 20 years ago or longer. A more current indicator is that approximately 65% of all current doctoral engineering students in the U.S. are from foreign countries. This flow of human resources to the U.S. continues but as we place more barriers against the entry of talented people and as more opportunities develop in their home countries, we will not be able to rely on them as much as we have.

Another feature of science today is that international collaboration in scientific projects has become much more common. Such collaboration is desirable for several reasons and

it is becoming more necessary for us in fields where we do not enjoy strong leadership positions.

Research Laboratories

American research universities are acknowledged to be worth imitating and many nations are trying to do so. While world rankings are not precise and are not even attempted often, it is widely believed that most of the best research universities are American. Students and researchers from around the world seek to enroll in, and affiliate with our campuses. The doctoral students who study and conduct research at our universities are extremely important to the science enterprise, along with postdoctoral researchers and faculty members. Our research universities and our liberal arts colleges also provide important opportunities for undergraduate students. Cooperative programs in which students enroll while also working for science and engineering companies, although not numerous, are very valuable as well.

After WWII until roughly the end of The Cold War, American corporations operated some amazingly distinctive and productive scientific research laboratories --- like those of Bell Labs where prodigious amounts of basic research were conducted. Bell Labs' scientific staff was star-studded and they won several Nobel Prizes, they published their own research journals, they created many advanced products and they contributed to the national defense, while also creating and maintaining the world's best telephone system. Other important research labs were at IBM, Xerox, Exxon, Chevron and Eastman Kodak.

Today, these corporate laboratories are still highly capable of developing new products (Intel, for example) and conducting superb applied research but they do very little basic research compared to earlier years. The major responsibility for conducting such research now is with our universities. It is an advantage, I believe, to combine research and graduate education so while our universities have more than enough responsibilities, the recently acquired burden of carrying the national research agenda fits well with the mission of education. And our system of American national laboratories and research institutes (some managed by universities) also represents important capabilities. It should be noted that research universities are also expected to serve as engines of regional economic growth.

American Philanthropy and Business Investments as Strategic Advantages

I want to mention two other strategic advantages enjoyed by American research. One is the American practice of philanthropy which is not practiced widely anywhere else. Private funds from individuals and foundations provide essential support for our research and for student scholarships and fellowships. Finally, American venture capital and other kinds of investment funds have contributed notably if irregularly to important scientific and technological developments.

Science as a Source of Good Will

American achievements and activities in science have created much good will worldwide. Significant numbers of foreign leaders attended American colleges and university graduate schools before returning to their homelands and they remain life-long friends.

A recent global public opinion survey found that admiration for U.S. science and technology remains nearly universal*. Another survey found that strong majorities of those surveyed in Morocco, Jordan, Lebanon and the United Arab Emirates have positive views about American science and technology. (2004 Arab American Institute/Zogby International Survey). There appear to be large opportunities for American science to become a major component of our diplomatic efforts while it also continues to undergird our economic and military strength.

Science Education.

In 2006, the National Academy of Sciences, the National Academy of Engineering and the Institute of Medicine produced a report called "Rising Above the Gathering Storm". It arose from a 2005 request from your Senate colleagues Lamar Alexander and Jeff Bingaman and discussions with Rep. Bart Gordon and other House members. The committee that authored the report was asked to identify actions which federal policymakers could take to enhance the science and technology enterprise so that the United States can successfully compete, prosper and be secure in the global community of the 21st century. The authoring committee of 20 distinguished Americans placed especially high priority on increasing America's talent pool by vastly improving K-12 science and mathematics education. They argued that it is essential to produce more teachers who are well-grounded in the sciences and mathematics themselves and to assist existing teachers to improve and maintain their science-content skills, and they proposed to use previously tested methods to achieve these goals.

The "Gathering Storm" report dealt with all levels of education through graduate and postdoctoral levels. While I trust that Mr. Norman Augustine will discuss this topic further, I want to emphasize how important it is to improve our K-12 science and math education. There are, of course, arguments about why American children do not stack up better than children of many other nations and whether the standardized tests give too much emphasis to factual knowledge as opposed to reasoning ability. Yet we receive few or no visitors from other countries who want to learn about and imitate our K-12 system while the movement to create foreign versions of our university graduate schools is large and intensive.

We have much work to do to improve our K-12 and college-level science and mathematics education. Not only do we want to increase the flow of human talent into high level science and research, we also want to fill the pipeline with science students so as to equip the nation's workforce to be able to create and manufacture products which take advantage of scientific breakthroughs. And we need a scientifically literate population to comprise an electorate informed on many contemporary issues. Finally, improved education enables individuals to launch productive careers.

The "Gathering Storm" report called attention to the importance of creating something like a new National Defense Education Act to provide support to science and engineering graduate students. There are some current reports from around the U.S. that applications to attend graduate science schools are up, apparently because of reduced job prospects for baccalaureate degree holders in industries including finance and investment. It is

especially important to provide support for these students not only to see them through their Master's and Ph. D. programs but also for postdoctoral research opportunities later.

Amongst these new and prospective new graduate students there is special interest in energy science and technology and in climate change. For example, working in the science and technology of materials that might be useful in capturing solar energy and in storing solar and wind energy is very attractive now. Similarly, plant science is extremely appealing now as we consider pathways toward advanced biofuels that would not decrease food production. And the science of climate change presents many fundamental and complex challenges that are perceived by young people who want to engage these challenges through science.

Supporting Science Today – A Special Opportunity

Earlier I mentioned our report "Rising Above the Gathering Storm". It presented four main lines of actions that the federal government should take to enhance the science and technology enterprise so that the United States can successfully compete, prosper and be secure in the global community of the 21st century. They are: vastly improve K-12 science and math education, increase federal support for science and engineering research, attract the best and brightest to American higher education in science and engineering, and create an environment for innovation through a combination of economic, legal and immigration policies.

"Rising Above the Gathering Storm" recommended special attention to increased federal investment in physical sciences, engineering, mathematics and information sciences and to DOD basic research funding. It focused importantly on energy science and technology research and somewhat on the National Science Foundation and the Department of Energy. This choice of emphasis is extremely important as the events of 2006-2008 have shown once again.

Although "Rising Above the Gathering Storm" omitted detailed discussion of NASA, NIST and NOAA, the work of these agencies complements that of NSF, NIH and DOE and these agencies are very important to addressing these new challenges, to American science and higher education, and to all that we must do.

The recently passed federal stimulus package has provided substantial support toward major national goals that have been arrived at very thoughtfully. The stimulus-bill funds aimed at American science will be used very productively and in forward-looking ways, I believe. Let us hope and resolve to make these new levels a baseline for further advances.

Thank you for inviting me to testify. I would be happy to address any questions that the subcommittee has.

Footnote* "Global Public Opinion in the Bush Years (2001-2008)" <http://pewglobal.org/reports/pdf/263.pdf>http://pewglobal.org/reports/pdf/263.pdf , which was released on Dec. 18, 2008 by the Pew Global Attitudes.