As we gather here for the 150th Annual Meeting of the National Academy of Sciences, I want to take some time to reflect on what the NAS has meant for science, for the United States of America, and for the world.

My somewhat eclectic tour of these subjects begins with a brief summary of the founding of the NAS and its mission, and then proceeds to recall some of the major impacts of science and technology developments of the past century or so, and some of the post-1950 changes in how science is conducted. I conclude with some general statements about how we can fulfill our mission in the future.

**Founding of the National Academy of Sciences and the Civil War**

It is notable that the founding of NAS happened at all. In 1863 while the United States was mired in its bitter Civil War, President Lincoln and Congress took a major step to advance the prospects for our young nation: The creation of the NAS was a bold initiative to elevate the quality of American science and to incorporate science into the future capabilities of the United States. Other actions taken by the federal government during this stressful time of the Civil War were also transformative. In 1862, Congress passed and President Lincoln signed the Morrill Act, creating Land Grant Colleges, which provided federal land grants to establish new colleges and universities, such as the University of Illinois and the University of California. It also supported some existing institutions such as Pennsylvania State University and the University of Wisconsin and some private colleges. The Morrill Act’s enduring impact was to greatly expand the capacity of the United States to provide higher education and to conduct scientific and technical research for a rapidly growing nation. Also in 1862, Congress authorized the completion of the Transcontinental Railroad. And on January 1, 1863, just two months before establishing the NAS, President Lincoln issued the Emancipation Proclamation.

The mission given to NAS was far-sighted and singular. It was to perform analyses and to advise the government as a private nonprofit organization outside of the government. In the language of the mid-19th century...
“the Academy shall whenever called upon by any department of the Government, investigate, examine, experiment and report upon any subject of science or art…”

In 1863, “art” meant the mechanical and agricultural arts. The Act (of Incorporation) continues:

“…but the Academy shall receive no compensation whatever for any services to the Government of the United States.”

The Act of Incorporation represents a delegation of power by the government to a group of private citizens to bring science to the service of the Nation; such a delegation is rare if not unique worldwide. In return, the NAS was expected to assure that its findings would be in the public interest.

To this day, we do not receive an annual appropriation from Congress. Instead (most of) our costs are reimbursed on a project-by-project basis, and we have the independence to determine the size of our membership and its composition amongst the disciplines. (1)

A New Scholarly History of the NAS
My speech today recalls some of the many ways that science and technology have changed the world, how the practice of science has changed and how the NAS has made a difference. Separately, I am happy to report that, as part of our effort to commemorate the 150th anniversary of the NAS, we have commissioned the writing of a new scholarly history of NAS authored by Professor Daniel Kevles, Professor Ruth Cowan and Professor Peter Westwick. The authors’ concept for the book is to integrate the NAS into the broader sweep of American history and document its responsiveness to and involvement in broader trends in public policymaking as well as its influence in the development of science, technology, and medicine. The authors have noted that while the NAS has from the outset enjoyed a degree of autonomy, it has not been wholly or even willingly insulated from the larger context of scientific, technological, and medical trends and events. This has been especially the case in its public advisory engagements. The world beyond the NAS also influenced its major activities, including notable internal developments such as the creation of the National Research Council and of the National Academy of Engineering and the Institute of Medicine.

Although the internal history of the NAS will be addressed, including how it dealt with the communities of engineering and medical science, the deliberations of the presidents, home secretaries, and foreign secretaries; and matters such as election to membership — the book will not be totally NAS-centric. The book will be finished in approximately two years.
Impacts of Science and Technology: A Quick, Eclectic Tour of the Past Century or So

Scientific discoveries and technological advances during the past 75–100 years have had enormously positive impacts on human society. Throughout this period, NAS/National Research Council studies helped to frame and guide public choices related to these opportunities and the issues that they raised. My selection of topics to mention here today is largely personal and does not reflect a systematic or scholarly compilation. Furthermore, I provide references to specific NAS/NRC reports very sparingly (2).

Early 20th Century through the 1960’s

Amongst the most noticeable and dramatic events were the electrification of urban and later, rural communities in the United States and elsewhere. Electrification changed homes and workplaces. For example, it enabled the widespread refrigeration of foods in homes, markets and warehouses and for transportation of foods. The development of synthetic refrigerant fluids, safer than ammonia, for example, also enabled widespread refrigeration. Electrification also enabled radio and later television to become ubiquitous.

The provision of nearly universal safe drinking water (in the U.S.) through the treatment of water and the separation and treatment of wastes led to rapid improvements in public health. Similarly, the introduction and mass production of penicillin had dramatic benefits.

In the first 30 years or so of the 20th century, relativity theory, quantum mechanics and the related physics of matter and its interaction with electromagnetic radiation were developed, the subsequent scientific and societal impacts of which have been enormous. Many scholarly and popular volumes have been written on these subjects and they are examples of topics which I will skim over here, despite their fundamental and widespread importance.

During World War I, aviation and meteorology were of interest to the U.S. military and the NAS was asked to conduct and report upon related research. (2)

By the time of World War II, aviation was used widely, as were radio and radar. The strategic value of weather forecasting was recognized, providing motivation for post-War developments. The atomic bomb was developed during WW II, altering military thinking and strategies forever.

Vaccines to prevent diphtheria, measles, mumps, rubella and other diseases were introduced along with the polio vaccines in the 1950’s and 1960’s and smallpox was eradicated in the U.S. in the 1960’s and 1970’s.

Commercial aviation grew very rapidly in the U.S. in the 1950’s and 1960’s and it continues to grow worldwide. Technological improvements enabled more reliable and safer operations.

Similarly, the nation’s infrastructure for surface transportation was improved dramatically by a multi-decade commitment to build the Interstate Highway System. By 1972, the effort was well underway with 34,000 miles completed and the Academy’s Transportation Research Board (then known as the Highway Research Board) played key roles in this massive undertaking. For example, research managed by the NRC via TRB helped to determine specific design methods and standards, including using field data for test sections of pavements and bridges. Such sections were subjected to nearly continuous field loading
due to heavy trucks and the resulting data were used to derive pavement-performance and design relationships used on Interstates for decades. Through TRB's National Cooperative Highway Research Program, additional research produced a steady stream of results that were incorporated into national bridge, pavement, drainage, and geometric design standards.

Surface transportation was propelled by gasoline derived from petroleum which in turn was provided mostly by domestic oil wells. Net imports of oil (imports minus exports) constituted only 10% of oil consumed in the 1950’s in the U.S., growing to 18% in the 1960’s. Net imports exceeded U.S. domestic production for the first time in 1997.

More than half of the electricity consumed in the U.S. was produced from coal burning in the 1950’s (52%) and 1960’s (53%). By 2011, coal's share had fallen to 43%.

Total U.S. energy consumption grew by 4.2% annually in the 1960’s and world energy consumption grew very rapidly in the 1960’s, as much as 7% per year.

These growing demands for energy, along with scientific and technological capabilities for the peaceful use of nuclear power, began the era of nuclear electricity power plants. Construction of such plants proceeded rapidly from roughly 1955 though 1980 although several notable accidents and/or leakage of radioactive material occurred beginning in 1979, slowing the trend. Today, over 100 nuclear power plants operate in the U.S., producing almost 20% of U.S. electrical energy consumption.

Following WW II, more powerful nuclear weapons were conceived and built through the remainder of the 20th century. An arms race proceeded for many years. During the Cold War (roughly 1950 to 1990) the physical sciences and engineering were supported by the federal government partly for military defense. The NAS also became involved indirectly in arms-limitations matters through, for example, the NAS Committee on International Security and Arms Control. The conception and launching of the International Geophysical Year (1957 and beyond) led to continuing international cooperation in Antarctica, the beginning of continuous measurements of atmospheric carbon dioxide and attention to the polar ice masses, for example. NAS’s role in IGY was substantial.

In the early 1950’s the molecular structure of DNA was discovered by James Watson and Francis Crick. In their research, they drew from X-ray crystallography results from a number of scientists, notably Rosalind Franklin and Maurice Wilkins, and from chemical reasoning. The discovery opened the doors to modern molecular biology and genetics and it guides the transfer of genetic material across species, permitting the engineering of traits and functions. Genetically modified organisms such as crops can now be produced more selectively and quickly. DNA-based methods have also provided deeper understanding of biological evolution, its mechanisms and pace.

The Watson-Crick discovery was followed by a large increase in molecular biology and genetics research and associated public hopes and fears, hopes for disease prevention and cures, and fears of cloning of humans and of threats (biohazards and other physical dangers and ethical transgressions) of certain kinds of recombinant DNA experiments (see 3, for example).

The “Green Revolution” was comprised of a number of research and development initiatives that began in the 1940’s and extended through the 1970’s. Through it, agricultural production increased around the world, dramatically in the late 1960’s. Hybridization of seeds for crops, the
increased usage of synthetic mineral fertilizers, improvements in irrigation and pesticides all contributed. Food shortages and starvation became less prevalent and nutrition improved.

The use of chemical isotopes for applications in earth science, anthropology, archaeology, biomedical research, in clinical settings, in tracer studies and other ways began to grow in the 1950’s and continued in following decades.

In the late 1950’s the former Soviet Union succeeded in orbiting an artificial satellite around the Earth. By the early 1960’s the U.S. started to prepare to place a human on the Moon, succeeding in 1969 (NAS reported in 1955 that such a project was feasible and advised the U.S. government to begin an effort to achieve it (2).

The social and behavioral sciences have been applied to a growing list of societal issues, starting in World War I, continuing through WW II, the Cold War and contemporary times as their conceptual bases and methods have become more refined. Examples include intelligence testing, survey research on public attitudes and for commercial interests, to gather information on public health, immigration and population. Elegant theoretical progress was made on fundamental topics such as decision theory, human learning and memory and information theory. Entire fields such as demography have developed with great value in framing options for public policy and similar applications.

A revolution in electronics (with multiple facets) was seen in solid-state semiconductor devices based on diodes, transistors and integrated circuits. Physicists, chemists and material science/engineering made very rapid advances in creating such devices. Digital, as opposed to analog, devices led to digital computing and communications, and the sizes of the devices shrank along with their power consumption, while their reliability and capacities for data transmission and storage grew dramatically. Numerical digital techniques from mathematics and electrical engineering were central in handling large quantities of digital data and the field of computer science was spawned. Numerical modeling became a new tool to study systems whose governing equations could not be solved with existing techniques.

Some of these advances created issues that required some interventions, both technological and governmental. They include questions of data security (personal, health, commercial and national security). The vulnerability of data records remains an issue today as “hacking” becomes more prevalent and more consequential, enabled partly by the sizes of data sets, by the reliability and permanence of storage technology, and by fast, accurate means of data retrieval. Particular vulnerabilities concern devices that are monitored and managed by control systems, themselves a product of the revolutions introduced by solid-state devices.

**Early 1970’s to Early 21st Century**

Awareness of energy usage, consumption of natural resources and concerns over pollution spread quickly in the early 1970’s after beginning slowly a decade earlier. Demand for energy grew dramatically after WW II, for example, electricity for household consumption, for air conditioners and freezers, and gasoline for transportation. The
Oil Crisis of the early 1970’s shocked the U.S. and other petroleum-importing nations. Notions of scarcity of resources became common along with the perceived need for energy efficiency and more nuclear power.

By the mid-1970’s, acid rain had been detected in numerous places around the world, with some evidence that the source(s) were coal-burning and combustion of other fossil fuels. Also, the first suggestions were published that the Earth’s stratospheric ozone layer could be degraded by (1) nitrogen oxides deposited into the stratosphere by aircraft and by upward movement of surface-released nitrous oxide (transformed from synthetic N fertilizers), and (2) chlorine carried by synthetic chlorofluorocarbon (CFC) gases. These ideas sparked much research in the 1970’s and 1980’s, partly due to concern over the biological effects of increased ultraviolet light at Earth’s surface. In 1985, the Antarctic Ozone Hole was reported and within several years, it was shown to be caused by chlorine from the CFC’s.

While the acidity of precipitation is largely proportional to the emissions of sulfur and nitrogen oxides from fossil-fuel burning, stratospheric ozone depletion involves the multiplicative effect of chemical catalysis, and the intensity of ultraviolet light on Earth’s surface is a multiple of the stratospheric ozone loss due to optical absorption along an atmospheric path. I mention these mechanistic factors because while it became clear in the 1960’s and 1970’s that population growth, consumption of energy and resources and rising standards of living might be causing scarcities and environmental impacts, it was not completely clear that major scientific efforts would be needed to quantitatively evaluate the impacts and to manage them, for example, by defining how new technologies could help. Also, from the public’s point of view, there was skepticism at first that chemicals measured in air in parts per billion or less could cause significant loss of the entire planet’s ozone layer. The understanding of scientists was needed, not just human intuition.

Human-caused climate change, which was perceived as a possibility in the 1800’s, was the subject of a 1979 NAS study and of many more recently, also involves multiplicative effects. People recognize the release of heat by human energy consumption (fossil fuels, hydroelectricity, nuclear power, renewable energy) and they wonder if it could cause global changes. Instead, it is the understanding of Earth’s black-body emissions spectrum and the spectroscopy of atmospheric gases, the realm of science, that explains the 100-fold amplification of human energy usage on Earth’s energy budget.

These examples illustrate that human population growth, increased consumption of energy and resources and pollution had become concerns and that serious science was required. Indeed, NAS members were influential in the identification of major problems and the limitations that they represented (2). An effect of these new concerns was the beginnings of a “reject-technology” movement, as technology began to be regarded with skepticism even though it had enabled so much human progress in the early and middle 20th century.

Land-surface alterations like clearing of forests for agriculture and for raising cattle were becoming more visible (from Earth’s surface and from space) by the mid-1980’s, as was the paving over of rural land for the establishment of suburbs and cities. The advent of instruments on Earth observing satellites documented Amazonian forest losses, for example. These data helped to enable estimates of the fraction of annual net primary photosynthetic production (NPP) that is used, diverted or wasted by
humans. One credible (late 1980’s) estimate was 33%, implying a strong physical limit on human population growth and consumption.

Some of the most striking changes apparent today are seen in cellular telephones and the usages of Global Positioning System data. Rapid voice and video communication, retrieval of large amounts of information and access to accurate geographical data are available to large numbers of individuals worldwide — without wires — changing personal behaviors and commercial patterns. To the users of such devices (including iPads and the like), there is little or no need to understand the sophisticated materials, electronics and software that are required for their operation, or to know that Earth-orbiting satellites enable these telephones and the GPS. A user simply presses buttons or swipes a finger across a screen.

Similarly sophisticated products are entering daily life in many nations in medical diagnostics and interventions — for example, the identification and detection of biomarkers for various diseases and their courses — in medical imaging, and the synthesis of designed pharmaceuticals. For example, major discoveries have uncovered the fundamental biology of RNA and retroviruses that has led in turn to productive research in genetics, molecular biology, microbiology and other fields and to science-based treatments against some diseases like AIDS in humans. Once again, the fundamental research and development that underpins such products is mostly unseen and incomprehensible to most citizens, and elected officials often need expert, unbiased advice.

**Population and Life Expectancy**

U.S. population reached 150 million in the 1950’s and world population passed 2.5 billion in 1950. By 2000, U.S. population had grown to 284 million and world population to 6.1 billion (4). Also in 2000, U.S. life expectancy had increased to 77 years from 47 years in 1900, largely due to clean drinking water, the treatment of wastes and wastewater, antibiotics and vaccinations. Increases in life expectancy continued in the first decade of the 21st century and some other nations have surpassed the U.S., for example in decreased infant mortality. Population growth has continued into the 21st century: today’s numbers are approximately 316 million (U.S.) and 7 billion (world).

Even a quick, incomplete tour through the last 75 to 100 years shows a number of very large developments, based in science and technology,
that caused large societal changes. Many patterns and developments have involved public choices and government decisions.

It is not surprising that our federal government needed advice along the way. The NAS and the NRC have been drawn into all of the issues related to changes such as those that I mentioned during this quick tour.

The Practice of Science from 1950 Until Now

Major changes have also occurred in the way that science is conducted in the U.S. especially since WW II, for example, through: federal funding, internationalization, group efforts, multi-national facilities, major improvements in instruments and numerical modeling. Once again, I am making only a quick tour through these events and changes, not a complete coverage.

We should remember that federal funding for science, or example, in universities, was very small until WW II, and it was mostly aimed at specific applications and developments. At the end of WW II, Vannevar Bush led efforts to convince the government to continue to fund university investigators and to direct more of it into basic science, including the social sciences. Questions arose from some in government about how well the government could control such activities and from some researchers who were leery of governmental control. The formation of the National Science Foundation emerged from such discussions. Funding for NSF began very slowly with $4 million in 1954 and $8 million in 1955 and several more doublings happened over the period of the 1950’s, 60’s, 70’s and early 1980’s.

It also took some time to sort out whether medical research would be supported by a separate agency. The National Institutes of Health (NIH) emerged as the dominant supporter of this research by the early 1960’s when its annual budget for research and development reached $250 million.

The large increases of federal funding provided during the 1960’s for universities, national and federal laboratories began following World War II, during an era of great optimism about the future. There was understanding and appreciation that science had helped greatly in the war effort, and the funding was propelled by economic growth that generated increased federal revenues.

To re-emphasize what a large change the federal research funding was about to make, consider what physicist Fred Seitz said:

“During the war relatively little thought was given by the universities to the influence of federal support on institutional policies, because most university staffs not only were absorbed in war activities but also felt that the flow of government contract money would stop promptly at the end of the war. Most of us hoped only that we would be permitted to keep some reasonable fraction of the equipment and related facilities that had been accumulated during the war.” (5)

By the final third of the twentieth century, federal funds had driven dynamic growth in the intensity and volume of research, and in the numbers of Ph.D. degrees granted. These impacts remain clear today. The doubling of the NIH budget (1997–2004) was extremely important. Another strength of the American system is that multiple agencies support research: DoE, DoD, NIH, NSF, NASA, USDA, NIST, EPA and DoT, for example. This array of competitive
peer-reviewed grant programs presents opportunities that offset some of the difficulties that investigators face when missions and criteria at a particular agency are not a good match for specific research. Testimony to the value of peer-review practices at U.S. federal agencies is provided by the fact that many other nations seek to adopt them after having tried other methods.

However, the picture today is strained by fiscal limitations. Federal stimulus spending helped greatly in 2010 and 2011 but because it was intended as a temporary economic stimulus, that funding was not sustained. In 2012, at NIH success the rate for grant applications fell to 18% and the average grant size was $460K. In 2009, before the federal stimulus funding, the corresponding NIH figures were 22% and $379K, respectively. At NSF, 2012 figures were 22% with a median grant size of $127K; NSF 2009 figures were 25% and $120K (usually, average grant size exceeds median size). Current outlooks are worse due to the 2013 sequestration of federal funds and longer-term limitations on all federal spending are threatening the future.

Low success rates for research-grant applications are exacerbating a set of problems that have arisen repeatedly over the past 40 years — new Ph.D.'s and M.D./Ph.D.'s are having more difficulty in launching their own research careers. Longer times to degrees and longer postdoctoral terms contribute as well. The scientific community and the federal agencies must continue to seek ways to address the discouragement that confronts young investigators.

Strongly related to federal funding for research, the Bayh-Dole Act (1980) provided a sensible, stable legal framework that transferred the ownership of intellectual property from federally funded research from the federal government to the grantee institution. The licensing of this intellectual property spurred job creation and economic growth in science- and technology-related sectors of the economy. This, in turn, has underscored the economic value of federally sponsored research. This commercialization of research has allowed all parties to benefit by providing ways for the federal government, research institutions and inventors/discoveries to share income from patent licenses.

American research universities were strengthened by increased federal spending for research; older universities began to place more emphasis on research and graduate programs and a number of relatively young universities began a rapid ascent into full research-university status. As the world economy became more globalized after 1990 notable R&D efforts at some major corporations (e.g., Bell Labs) shrunk and many corporate investigators left for American research universities, which was a one-time gain for universities.

The exciting research environment of the past 50 years or so fed on itself in tangible ways. Invention and improvements in instrumentation led to gains in sensitivity and specificity of measurements that in turn led to more discoveries. Increased capabilities in data acquisition, storage and visualization allowed data to be examined more deeply. Miniaturization of instrumentation such as optical systems and their associated electronics provided access to smaller volumes of material with many examples from analytical chemistry to biochemical systems. Digital computers and advances in computer memory and in numerical methods to solve systems of differential equations have enhanced the value of numerical modeling — for simulations, sensitivity studies, design of systems and other key applications.

In the conduct of research as with many related fields of employment, human resources issues
took on greater importance. Notably, women earned greater fractions of newly awarded Ph.D. degrees in many fields during the last third of the 20th century, and the U.S. continued to attract many foreign students to U.S. graduate programs and to the scientific and technical workforce. Of the NAS membership, women comprised fewer than 1% in 1963, 6% in 2000 and 12% in 2012. Approximately 25% of NAS members were born in other countries.

The research enterprise also became more international as manifested both in contributions from a larger number of nations in individual fields of science and also by the fraction of publications with co-authors from different nations. Similarly, many fields of science have seen strong trends toward multi-authored papers.

The rapid communication of research results (data, graphs, figures and entire papers) over the Internet has enabled both the internationalization of science and collaboration among multiple authors. Electronic communications have also enabled wider, quicker and more open access to research results and to journals.

Scientific journals have served essential roles in established and new disciplines of science, have grown in size and numbers and have adopted many improvements in the current digital age. Yet they are under continued economic pressure as subscriptions decrease and more readers seem to read only targeted papers as opposed to all of the papers in an entire issue of the journal. The entire system of page charges and countervailing pressure for open, quick, free access to papers, and the reliance on pro-bono reviewers and editors as opposed to paid editorial staff has not yet been settled for the future. Many scientific societies have depended on income from publishing to support other important activities. Important questions remain to be answered in the world of scientific journals, as with libraries.

American research universities are recognized throughout the world for their quality and research productivity. They also offer undergraduate research experiences that can be transformative: the combination of classroom education and laboratory-based research opportunities contribute value to society and to individual students. In 2013, we are seeing many questions about costs of undergraduate education. At public universities, decreased state support often results in increases in student fees and tuition for undergraduate students, increases that are felt as costs to the public. Meanwhile the benefits of basic research are often not immediate and are not as easy to state.

Science and technology are at the heart of many public policy issues. This is especially true where private and public interests intersect, and possibly conflict, for example, in legal and regulatory matters, commercial, environmental and medical disputes and developments, and issues of personal privacy. The increasing relevance of scientific research has made us all, and our home institutions, aware of the need to disclose relevant personal financial interests, for example. Also paramount is the need to make research data as accessible as possible, as soon as possible. Standards for accessibility are needed for each field of science, and science leaders must be at the forefront of these efforts. (6)

Leaders of science have initiated discussions on the responsibilities of scientists in the conduct of research, for example, in matters of laboratory safety and in anticipating and responding to public concerns over altering genetic material of organisms (animals and plants), nuclear weapons, and biohazards; see (5), for example. Similar issues arise in physical science as with nuclear weapons research. While moral and ethical concerns rightly involve many non-scientists, scientists are needed in such discussions.
Political polarization over some scientific topics is a current problem; its form is unusually stark and without much precedent. A number of prominent politicians have spoken very pejoratively about the science of biological evolution, climate change, the age of the Earth and the social and behavioral sciences. This recent pattern is puzzling because science in general enjoys widespread support in Congress and in the public. I maintain that the NAS can help most by adhering to scientific positions and not by entering into battles that spread onto non-scientific turf.

This brief summary, incomplete as it is, of how the practice of science has changed roughly since the 1950’s, reveals enormous changes, the pace of which is increasing. American science is a large enterprise on an increasingly active world stage. Because science is so relevant to society today, it is essential to guide the enterprise toward continued improvement. For example, investigating big questions is always important whether they are fundamental and seemingly irrelevant or aimed at large societal issues like sustainability. Improving opportunities and involvement of historically underrepresented groups both in research and K–12 education is more urgently needed than ever.

**Is NAS Ready for the Future?**

The mission of NAS is multi-faceted (1): the NAS has a primary role in validating scientific excellence; in enhancing the vitality of the scientific enterprise; and in communicating the nature, values and judgments of science to government and the public. NAS activities are limited only by NAS’s sense of priorities and resources. The main mission given to NAS in its Charter, using science to guide public policy, carries with it corresponding responsibilities. We must be able to draw from experts in all fields, we must remain independent and non-partisan, and reports must be objective, up-to-date and robust against criticism. Over the years, the National Research Council has developed capabilities and processes to satisfy these requirements and it has greatly expanded the scope and capacity of NAS’s operations.

Many of the questions that the government addresses to us are quite applied; real-world issues have a way of being so. We cannot predict exactly what questions will come to us although one can anticipate that the effectiveness and costs of health care will continue to be hot topics, and that there will be more interest in personalized medicine. More questions about the costs and benefits of basic research will arise and the prospects of various fields of science will require evaluation, as will technical aspects of nuclear wastes. Many of the issues that I mentioned earlier are likely topics as well.

We are well-positioned for tomorrow’s challenges, like those mentioned above, many of which are broad, multi-disciplinary problems of a rapidly changing, science-based world society.

Because the mission given to us is so important and rare worldwide, we must maintain our credibility and capacity as outlined above in requirements. A very important foundation for this needed credibility is the NAS membership itself. The participation of NAS members in projects of the National Research Council, as study-committee members and as reviewers, is essential. I want to encourage you to participate in our study committees or to serve as independent reviewers of our reports.

Also, when we imagine dealing with the broad, multidisciplinary issues of the future, we can see the advantages that accrue by working with the NAE (established in 1964) and the IOM (1970) to oversee NRC and IOM projects, in contrast to operating separately. In most other countries, our counterparts are separate from one another.
and analysis of some complex issues is impeded. Our partnership with NAE and IOM also increases our ability to attract key expert volunteers and staff and it enhances our capacity.

Even though the importance and scope of science have grown so much over the history of NAS, and the future questions to be addressed to us are mostly not predictable, I am confident that the NAS and its partner academies are capable of rising to the challenges; we are indeed ready for the future.

REFERENCES


2. Reports from the National Research Council, the National Academy of Sciences and the Institute of Medicine are available over the Internet and through the National Academies Press for the years 1994 through 2013. NAS is working to provide online access to the titles and dates of all reports prior to 1994 but it is not yet available. A list of all studies and projects completed is available year-by-year in NAS’s Annual Report to Congress.


