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Bulletin

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Academy Report Stresses Importance of Science and Engineering Research for American Prosperity and Competitiveness

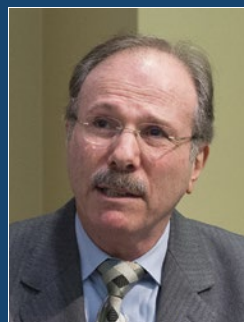


Ocean Exploration: Past, Present, and Future

Robert D. Ballard

Russia – At the Crossroads Again?

Valerie Bunce, Timothy J. Colton, and George W. Breslauer



ALSO: 2014 Induction Ceremony
GNF Project Proposes an Interim Storage Concept for the
Back-End of the Nuclear Fuel Cycle
In Memoriam: Robert W. Fri

Upcoming Events

FEBRUARY 2015

24th

Duke University,
Durham, North Carolina

*The Unstable Biomedical Research Ecosystem:
How Can it Be Made More Robust?*

Featuring: **Nancy C. Andrews** (Duke University School of Medicine), **Tania Baker** (Massachusetts Institute of Technology), **Richard H. Brodhead** (Duke University), **Jonathan F. Fanton** (American Academy), **Mark Fishman** (Novartis Institutes for BioMedical Research), **Sally Kornbluth** (Duke University), **Harold Varmus** (National Cancer Institute), **Susan Wentz** (Vanderbilt University)

MARCH 2015

5th

House of the Academy,
Cambridge, Massachusetts

40 Years of Evolution

Featuring: **Peter R. Grant** (Princeton University), **B. Rosemary Grant** (Princeton University), **Jonathan B. Losos** (Harvard University)

30th

House of the Academy,
Cambridge, Massachusetts

An Evening with Robert Levin and Ya-Fei Chuang

Featuring: **Robert Levin** (Harvard University; Sarasota Music Festival), **Ya-Fei Chuang** (Boston Conservatory; New England Conservatory)

APRIL 2015

2nd

Emory University,
Atlanta, Georgia

Digital Humanities

Featuring: **G. Wayne Clough** (Smithsonian Institution), **Anne Cong-Huyen** (Whittier College), **Charles Henry** (Council on Library and Information Resources), **Stephen Nichols** (Johns Hopkins University), **Angel Nieves** (Hamilton College), **William G. Thomas** (University of Nebraska-Lincoln)

16th

House of the Academy,
Cambridge, Massachusetts

Technology & the Contemporary Self

Featuring: **Peter Galison** (Harvard University)

30th

Rice University,
Houston, Texas

*Baker Institute Civic Scientist Symposium,
featuring "Restoring the Foundation"*

Featuring: **Norman R. Augustine** (Lockheed Martin, ret.), **Steven Chu** (Stanford University), **Neal Lane** (Rice University), **Jonathan F. Fanton** (American Academy)

MAY 2015

4th

The Century Association,
New York, New York

*Reception for New York Area Fellows
and Guests; Welcome Newly Elected Fellows*

11th

House of the Academy,
Cambridge, Massachusetts

Lecture-Recital: *Discovering Handel's
London Through His Music*

Featuring: **Ellen T. Harris** (Massachusetts Institute of Technology) and a performance by musicians of the **Boston Early Music Festival**

*For updates and additions to the calendar,
visit www.amacad.org.*

Reminder to Members

The Annual Fund – Still time to participate by March 31

This year's Annual Fund Campaign concludes on March 31st. To make your gift online, go to www.amacad.org, click Contribute, then click DONATE. You will receive an immediate electronic acknowledgement that your gift has been received.

Generous Annual Fund contributions from members help to support all that the Academy does, including projects and publications, the website, outreach, meetings, and other activities in Cambridge and around the country.

If you have already made your gift to the Annual Fund, thank you!

For assistance in making a gift, contact the Development Office at dev@amacad.org; 617-576-5057.

From the President

James Bowdoin, the first president of the American Academy, was inaugurated on November 8, 1780, in a meeting house not far from the Academy's modern headquarters in Cambridge, Massachusetts. In his inaugural address, entitled "A Philosophical Discourse, Addressed to the American Academy of Arts and Sciences," Bowdoin imagined that future generations of Americans would look back on that moment with great admiration:

It was not to be expected that our ancestors, involved in a civil war, could give any attention to literature and the sciences; but superior to their distresses, and animated by their general principles . . . they instituted the excellent society, called *The American Academy of Arts and Sciences*.

Our new publication, *Advancing Knowledge: Selections from the Archives of the American Academy of Arts & Sciences*, provides insight into the many ways that the Academy has nurtured "literature and the sciences" since Bowdoin's time. I encourage you to read the article about *Advancing Knowledge* in this issue of the *Bulletin*, and then to peruse the book itself, which offers a fascinating overview of the Academy and its Fellows through history, including more information about Bowdoin's remarkable "Philosophical Discourse."

Bowdoin's inaugural address described the interests and preoccupations of Academy Fellows at the founding moment, including the study of the natural and cultural histories of North America – the literal and figurative roots of the new nation. This issue of the *Bulletin* illustrates how the Academy today is realizing Bowdoin's vision.

The "Academy at Work" section provides an overview of our current projects and publications. The lead stories on our new report on science policy, *Restoring the Foundation: The Vital Role of Research in Preserving the American Dream*, and the important work of our Global Nuclear Future Initiative chronicle the Academy's efforts in advancing sensible public policies at home and addressing global security challenges. And the coverage of our recent presentations includes the remarks of several new members, who helped make our 2014 Induction Weekend such an informative and moving event. I hope that you will read these wonderful presentations and be inspired to join us in Cambridge for the 2015 Induction Weekend on October 9–11, 2015.

All of these projects, publications, and events reflect the passions of our members, who continue to work through this "excellent society" to advance the arts and sciences, and to serve the public good. I am grateful to all of you for upholding the "general principles" of the American Academy.

A handwritten signature in black ink that reads "Jonathan F. Fanton". The signature is written in a cursive style with a large, stylized initial 'J'.

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Restoring the Foundation: New Report Stresses Importance of Science and Engineering Research for American Prosperity and Competitiveness

A recent Academy report, *Restoring the Foundation: The Vital Role of Research in Preserving the American Dream*, argues for the importance of research, especially basic research, in maintaining America's competitiveness and the health and prosperity of its citizens. Chaired by Norman R. Augustine (Lockheed Martin Corporation, retired) and Neal Lane (Rice University), the report calls attention to the United States' comparative decline in research investments over the past decade and offers recommendations for sustaining long-term thinking in science and technology (S&T) policy, and for strengthening the partnership among government, universities, and industry (GUI).

On September 16, 2014, the Academy released *Restoring the Foundation* at a press conference and Congressional briefing in Washington, D.C. Rush Holt, Representative for New Jersey and Cochair of the House R&D Caucus, spoke at both events, remarking that "Americans deserve a more optimistic vision for our country and for our government. We should match, I think, the amazing potential that our entrepreneurs and engineers present us with the support of modern infrastructure and direct support where appropriate. This will create new technologies and develop alternate energy sources, or in the words of this report, it will make the American Dream available for all."

Project committee member Bart Gordon, former Representative for Tennessee and former Chairman of the House Committee on Science and Technology; Association of American Universities President Hunter Rawlings; and Association of Public and Land-grant Universities President Peter McPherson also applauded the report, supporting its core sentiment that scientific and technological advances, which are grounded in basic research, are fundamental to the prosperity, health, and security of the American people.

Nearly one hundred university leaders, directors and staff from federal research agencies, representatives of professional societies and the national laboratories, and members of Congress and their staffs attended the release events, which were webcast live via the Academy's website. The report's release was covered in *Science*, *The Chronicle of Higher Education*, *U.S. News & World Report*, and other media outlets. Both the report and video from the release events are available on the Academy's website at www.amacad.org/restoringthefoundation.

BUILDING SUPPORT

The project committee is engaging in extensive dialogue in Washington, D.C., and across the country to identify promising pathways to implement the report's recommendations. Committee members have arranged more than thirty-five meetings with Congressional offices from both major parties to discuss the report and explore possible mechanisms to encourage bipartisan cooperation on



Norman Augustine (Lockheed Martin Corporation, ret.), **Rush Holt** (U.S. House of Representative), and **Neal Lane** (Rice University)

research issues. Neal Lane also presented the report to the National Science Board and to over one hundred administrators and staff at the National Institute of Standards and Technology.

In addition, two committee members – Nobel Laureates Thomas R. Cech (University of Colorado Boulder) and Steven Chu (Stanford University; former U.S. Secretary of Energy) – highlighted the report's message in an October 15 op-ed in *The Wall Street Journal*, "How to Stop Winning Nobel Prizes in Science." They emphasized the need for steady federal funding of basic research, writing that "vacillation in the government's commitment to basic research makes strategic planning all but impossible for the nation's research institutions including universities, medical schools and national laboratories, and the companies they partner with . . . In short, not only must we invest, but also we must generate a framework in which that investment can thrive."

The Academy has assembled a coalition of scientific and business organizations to establish a task force on long-term planning on science and technology policy, with the goal of bringing together



Peter Littlewood (Argonne National Laboratory), Randy Hultgren (U.S. House of Representatives), and Neal Lane (Rice University)

S&T-focused organizations to deliver a common message to policy-makers and the American people. Participating organizations include the Association of American Universities, the Association of Public and Land-grant Universities, the American Association for the Advancement of Science, the Alliance for Science and Technology Research in America, Research!America, the National Academy of Engineering, and the Institute of Medicine of the National Academies.

MAINTAINING A FOCUS ON CRITICAL ISSUES

The Academy is convening an extensive series of symposia and workshops across the country to promote dialogue among leaders in government, universities, and industry, and to identify ways to enhance cooperation among these sectors. Some of the topics that will be explored include the sustainability of the biomedical research enterprise; university-industry research partnerships in biomedicine; research partnerships in information technology; and new models for technology transfer and intellectual property management.

An initial workshop was held on November 6, 2014, at the University of Chicago and focused on collaborations among national laboratories, universities, and industry. The participants included U.S. Representatives Randy Hultgren (R-IL) and Bill Foster (D-IL), Argonne National Laboratory Director Peter Littlewood, Fermi National Accelerator Laboratory Chief Operating Officer Timothy Meyer, and thirty representatives from national laboratories and their university and corporate partners. The workshop identified promising new models for research partnerships and highlighted

the benefits of colocalizing research and development activities to maximize the potential for new innovations. Representative Hultgren spoke about the importance of providing entrepreneurship opportunities for university researchers, remarking that “If there is not a way for our researchers to give the American Dream a shot and build a business . . . [that] is talent lost.”

The Academy is also working with the university community to identify steps that could be taken on campuses across America to advance the recommendations from *Restoring the Foundation*. Committee member Venkatesh Narayanamurti (Harvard University) presented the report at the November 2014 annual meeting of the Association of Public and Land-grant Universities as part of a panel moderated by Kelvin Droegemeier, Vice President for Research at the University of Oklahoma and Vice Chair of the National Science Board. The Academy is now working with Dr. Droegemeier to organize a conference in the summer of 2015 that will convene university research vice presidents and state officials from NSF EPSCoR (Experimental Program to Stimulate Competitive Research). The objective of the meeting is to foster new interinstitutional collaborations that encourage the sharing of experience and the rapid adoption of innovative policies and practices.

The conversations taking place across the country will provide a venue for a system-wide assessment of progress on overcoming barriers to the discovery of new scientific knowledge and technologies, the translation of these discoveries to business and industry, and the training of a future STEM workforce that is commensurate with maintaining America’s position of scientific leadership in the world. Together, they will ensure that *Restoring the Foundation* – and similar reports from other organizations – do not fade from the collective consciousness, but continue to drive thoughtful discussions for years to come.

More information about *Restoring the Foundation* may be found on the Academy’s website at www.amacad.org/restoringthefoundation. The Academy gratefully acknowledges support from the Alfred P. Sloan Foundation, the John D. and Catherine T. MacArthur Foundation, and the Hellman Fellows Fund. ■

Global Nuclear Future Initiative Proposes an Interim Storage Concept for the Back-End of the Nuclear Fuel Cycle

The problem of accumulating nuclear waste is prompting demonstrations and social mobilization in countries where governments have failed to develop a credible and effective strategy for the back-end of the nuclear fuel cycle. In South Korea, for example, protests erupted in 2013 against a government proposal that recommended four sites as candidates to host a nuclear waste storage facility. No decision has yet been made on the actual site. In addition, because the ongoing 123 Agreement negotiations between South Korea and the United States have been challenging (with the United States and the Republic of Korea [ROK] fundamentally disagreeing about ROK fuel enrichment and used-fuel reprocessing), South Korea's ability to build domestic uranium enrichment facilities and to reprocess its accumulating inventory of used nuclear fuel have been put on hold.

Similarly, the Japanese government has developed plans to store domestically highly radioactive waste from nuclear power plants deep underground. It is also pursuing the reprocessing of spent fuel from light water reactors in order to recycle it (by producing MOX fuel) as an interim strategy, buying time before the permanent repositories are in place (much as has been done in France). Since 2013, it has asked the local governments and prefectures to come up with candidate repository sites under a law that went into effect in 2000. But no municipalities have come forward, and the government still has not secured any candidate permanent repository sites. As an increasing number of nuclear power plants come back online after halting their operations following the accident at the Fukushima Daiichi Plant, the quantity of nuclear waste will increase, demanding storage solutions.

More recently, the problems with accumulating nuclear waste without a strategy for the back-end of the nuclear fuel cycle were discussed in an article published in the *Taipei Times*, on March 13, 2014:

In Taiwan, those behind the development of nuclear energy in the nation failed to consider whether there is enough space in which to store three or four decades' worth of spent fuel. With six reactors in continuous operation, the country is beginning to run out of places to put spent fuel and the initial single layer of radioactive waste has doubled. . . . Given this, it seems inevitable that sooner or later, a high-concentration radioactive leak will occur that will turn this beautiful country into a ghost island that will be impossible to bring back to life.



ORIGINS OF THE GLOBAL NUCLEAR FUTURE INITIATIVE

Since 2008, with support from the John D. and Catherine T. MacArthur Foundation, the Alfred P. Sloan Foundation, the William and Flora Hewlett Foundation, Carnegie Corporation of New York, the Flora Family Foundation, and the Kavli Foundation, the American Academy's Global Nuclear Future (GNF) Initiative has been addressing the safety, security, and nonproliferation concerns that arise as civil nuclear energy expands. The GNF Initiative focuses on a

number of key policy areas, including the international nonproliferation regime, the physical protection of nuclear facilities and materials, the interaction of the nuclear industry with the nonproliferation community, and the entirety of the fuel cycle, including viable strategies for the management of nuclear used fuel. Following a series of consultations in the Asia Pacific region and in the Middle East, GNF Cochair Robert Rosner (William E. Wrather Distinguished Service Professor in the departments of Astronomy & Astrophysics

GNF Cochair Robert Rosner has advanced the idea that the most realistic and cost-effective way to manage nuclear spent fuel today is to encourage the development of multilateral interim consolidated storage based on the use of dry-cask technology.

and Physics at the University of Chicago) has advanced the idea that the most realistic and cost-effective way to manage nuclear spent fuel today is to encourage the development of multilateral interim consolidated storage based on the use of dry-cask technology. He discusses this concept in a recent Academy Occasional Paper, *The Back-End of the Nuclear Fuel Cycle: An Innovative Storage Concept*, written with Stephen Goldberg and James P. Malone.

The reasoning behind the concept of interim consolidated storage is simple. The nuclear fleets that are being built by nuclear newcomers today, including Vietnam, the United Arab Emirates, and Turkey, will be significantly smaller than the ones built in the 1960s in the United States, Russia, China, India, and France, to name a few. This means that although the nuclear waste produced by these new nuclear programs will pose the usual problems in terms of management and governance, the quantity of waste generated will not necessarily justify the construction of national permanent repositories. Multilateral solutions would therefore be an ideal way to manage the problem since they would allow countries with small nuclear energy programs to combine resources. In addition, if executed correctly, a multilateral interim storage proposal would have many benefits for the international community. For example, by collecting all nuclear waste in one facility, the international community could better control the management of the nuclear waste and protect it from diversion, sabotage, or theft. Ideally, such multilateral arrangements would involve a permanent repository. Because the nature of a permanent repository depends on how it will be used, the multilateral partners must agree on the following: the repository will need either to have retrieval capability (if there is any intention of eventually reprocessing the used fuel) or have no retrieval capacity (if there is no intention of ever reprocessing). Unfortunately, such agreement has proved to be difficult to obtain in practice, and therefore multilateral arrangements for a permanent repository have not moved forward. Nevertheless, getting the used fuel away from the reactor sites and consolidating it under international supervision remains hugely beneficial from the safety and security perspectives – and this motivated Rosner and collaborators to look into an interim consolidated storage scheme.

An interim consolidated storage proposal does not belittle the responsibilities that countries with nuclear energy still have vis-à-vis their respective societies to establish – either individually or collectively – permanent nuclear disposal sites. However, multilateral interim consolidated storage offers an opportunity to establish a buffer between the time when

fuel is discharged from the reactor and the time when a permanent solution becomes available, and to do so without having to make an immediate commitment either to reprocess or not to reprocess.

Since the publication of *The Back-End of the Nuclear Fuel Cycle: An Innovative Storage Concept*, the GNF project leaders and advisors have reached out to potential customers and host countries of an interim storage facility:

- In November 2012, the concept was presented at a GNF conference held in cooperation with the Vietnamese Ministry of Science and Technology in Hanoi, Vietnam;
- In June 2013, the idea was discussed at an academic conference hosted by Hitotsubashi University in Tokyo, Japan, and also at policy briefings with the Japanese Atomic Energy Agency;
- In October 2013, the proposal was presented at an academic conference hosted by the University of South Korea in Seoul, South Korea;
- In January 2014, the concept was discussed at a conference held in partnership with Paramadina University of Indonesia in Bali, Indonesia;
- In June 2014, the proposal was discussed at a series of briefings with the heads of the Turkish Nuclear Regulatory Agency in Istanbul, Turkey;
- And in September 2014, the concept was presented during policy briefings with representatives from the U.S. Department of State and U.S. Department of Energy.

These domestic and international consultations revealed widespread interest in the proposal, ranging from support for the idea to a more direct interest in becoming either the host of the multilateral facilities or one of its first users.

In order to further assess the feasibility of the interim storage concept, the GNF project has commissioned two new papers: one will develop the business case for building and operating the facility; and the second will explore the modalities for spent-fuel governance. The business strategy paper will detail the financial support that would be required to build the interim storage facility and identify the type of economic incentives that a country may have to host such storage. The governance paper will advance a series of

Multilateral interim consolidated storage offers an opportunity to establish a buffer between the time when fuel is discharged from the reactor and the time when a permanent solution becomes available.

recommendations on how the spent fuel has to be managed.* Both customer and provider states must agree to participate in the multilateral facility, which they need to be able to sell to the public on the basis of its political and technical benefits.

MOVING FORWARD

In 2015, the Academy is continuing to work to expand and broaden the interim consolidated storage proposal in order to make it more viable for countries such as Japan, South Korea, and Taiwan, whose governments are currently locked into a decision stalemate on how to dispose of their nuclear waste. One area that the GNF project plans to investigate is the nature of model legal frameworks that could enable the creation of a multilateral consolidated interim storage facility: the point at which the various issues to be dealt with – such as economics, liability, sovereignty, security, and safety – all come together. Here, too, the GNF project considers it essential that the successful crafting of such a framework be an iterative process, with close participation by all who might be potential partners in such a multilateral scheme. ■

Forthcoming

The Back-End of the Nuclear Fuel Cycle: Establishing a Viable Roadmap for a Multilateral Interim Storage Facility

Robert Rosner (University of Chicago), *Foreword*

Lenka Kollar (Nuclear Undone), *Back-End of the Nuclear Fuel Cycle: Governance and Liability*

James P. Malone (Lightbridge), *Back-End Governance and Liability Business Plan*

* These recommendations include: 1) the host state needs to volunteer to host the facility, with the location chosen by a consent-based approach (clear economic, technical, and political incentives should be presented to attract a host); and 2) a host state should meet the same standards of safety and security that are required for states that want to become nuclear power states under IAEA guidelines, including having the necessary human and technical capital.

The Academy at Work: Research Projects and Studies

On October 11, 2014, as part of the Academy's 2014 Induction weekend program, new Members were briefed on the Academy's research projects and studies. The speakers, who play an active role in one or more Academy projects, highlighted the studies' current activities and the many opportunities for new Members to participate. The presentations focused on projects in Science, Engineering, and Technology; Global Security and International Affairs; and the Humanities, Arts, and Education. Below is an edited version of the speakers' remarks.

Science, Engineering & Technology

New Models for U.S. Science & Technology Policy



Neal Lane

Neal Lane, a Fellow of the American Academy since 1995, is the Malcolm Gillis University Professor and Professor of Physics and Astronomy Emeritus at Rice University and a Senior Fellow for Science and Technology Policy at Rice University's Baker Institute for Public Policy. He chairs the Academy's Initiative on Science, Engineering, and Technology, and is Cochair of the New Models for U.S. Science and Technology Policy study.

While the focus of our report is on the importance of basic research, we frame our arguments around the American Dream of a quality livelihood in a strong economy, which, among other things, requires quality education and a robust research enterprise.

Throughout its history, the American Academy has been deeply concerned with both the pursuit of scientific knowledge and the implications of scientific and technological advancements for society. Those concerns lie at the heart of the Academy's projects in the area of science, engineering, and technology, which our first panel of speakers will discuss.

In 2008, the Academy published its first *ARISE* (Advancing Research in Science and Engineering) report. This study, which was chaired by Nobel laureate and chemist Thomas Cech, focused on two primary issues: support for early-career investigators and support for high-risk/high-reward research. Last year, the Academy published a follow-up report, appropriately called *ARISE II*, which explored how to encourage transdisciplinary collaborations and create structures to allow those collaborations to flourish. The *ARISE II* project was chaired

by Keith Yamamoto of the University of California, San Francisco and Venkatesh "Venky" Narayanamurti of Harvard.

In September 2014, the Academy published a new report focused on the future of the national science and engineering research enterprise entitled *Restoring the Foundation: The Vital Role of Research in Preserving the American Dream*. I had the privilege of cochairing that report with Norman Augustine, retired CEO of Lockheed Martin. Our report is dedicated to the late Chuck Vest, who often remarked about the path that took him from a kid growing up in West Virginia to the President of MIT: how important education and science and engineering were to him and to his life, and how he lived the American Dream. While the focus of our report is on the importance of basic research, we frame our arguments around the American Dream of a quality livelihood in a strong economy, which,

New Models for U.S. Science & Technology Policy

among other things, requires quality education and a robust research enterprise.

The suggestion that the Academy carry out the study came from a Fellow of the Academy, a past university president concerned about shortcomings in science policy. A little over a year ago, the American Academy assembled the New Models for U.S. Science and Technology Policy Study Committee, which comprised leaders from various sectors, many of whom have experience in the world of policy. They set out to explore what the nation should do to ensure America's leadership in science, engineering, and technology in an increasingly complicated world. The Academy staff – in particular, John Randell and Hellman Fellow Dorothy Koveal – also provided strong support for the project.

Throughout the year, the project chairs, Committee members, and Academy staff met with administration officials, members of Congress on both sides of the aisle, academic and business leaders, leaders of the research community, and others who care about the future of science, engineering and technology in our country. These meetings informed the Committee's research and the resulting report, which was released on September 16, 2014. The report rollout included a Congressional briefing in Washington and a roundtable and dinner attended by representatives of several nongovernment organizations that share the Committee's concerns.

Now Nancy Andrews will speak about the basis for the study, how it was framed, and why.



Nancy C. Andrews

Nancy C. Andrews, a Fellow of the American Academy since 2007, is Dean of the Duke University School of Medicine and Vice Chancellor for Academic Affairs. She is also the Nanaline H. Duke Professor of Pediatrics and Professor in the Department of Pharmacology and Cancer Biology. She previously served as Director of the Harvard-MIT M.D.-Ph.D. program and as Dean of Basic Sciences and Graduate Studies at the Harvard Medical School. She is a Member of the Academy's Board of Directors and is a committee member for the New Models for U.S. Science and Technology Policy Study.

Restoring the Foundation asserts that the American science, engineering, and technology research enterprise is at a critical inflection point, and that the decisions policymakers and leaders make over the next few years will determine the trajectory of American innovation for decades to come. The report describes the challenges that lie before us and is meant to serve as a call to action. In the words of Norman Augustine, who cochaired the Committee, "We must start to think about our future if we are to have a future."

Looking back, America's remarkable post-World War II rise to international preeminence in science and technology can be attributed to decades of investments made in research and education. We see the benefit in our own lives: our life expectancy is nearly twice that of our grandparents because many devastating infectious diseases have been conquered and many other conditions, such as cancer and coronary artery disease, are much less likely to be lethal. We carry pocket devices that not only let us communicate (and take selfies) from almost any place on the planet, but also can instantly provide more information than a library.

The past seventy years of research and innovation have also provided enormous economic benefit in the form of new efficiencies, businesses, and careers. But America's future does not look as bright. In a number of areas, we can no longer claim the preeminence that we have taken for granted. As a country, we are seventh in the world in basic-research investment and tenth in total research-and-development investment; our students are seventeenth in reading, twentieth in science, and twenty-seventh in math.

As our investment in research has languished, other countries have recognized how vital a strong research enterprise is for economic growth and for the quality of life of their citizens. They are now trying to emulate America's successes. In less than ten years, China is projected to outspend the United States in research and development (R&D), both in absolute terms and relative to the economy. We risk losing the advantage America has long held as an engine of innovation that not only generates new knowledge and products, but new jobs and industries.

Innovation relies on breakthrough discoveries, which are largely the products of fundamental, curiosity-driven, basic research. We therefore believe that basic research is the foundation upon which the nation's science, engineering, and technol-

The American science, engineering, and technology research enterprise is at a critical inflection point, and the decisions policy-makers and leaders make over the next few years will determine the trajectory of American innovation for decades to come.

ogy enterprise rests. Most basic research takes place in universities, but the primary source of funding for this research is the federal government, not the universities themselves. The government-university partnership dates back to World War II. The U.S.'s basic research enterprise was bolstered in the mid-twentieth century when a number of large corporations also established in-house R&D laboratories, such as the iconic Bell Labs, which supported a considerable amount of basic research. An impressive number of Nobel prizes were awarded to researchers from those industry labs. But Bell Labs and many of the others have closed. Companies increasingly depend entirely on the government and universities to provide the basic-research pipeline for innovation. They find it increasingly difficult to justify the long-term – and often risky – investments required for basic research, even as the demand for new breakthrough discoveries persists.

America needs a more robust partnership between government, universities, industry, and philanthropy. Other countries have used this strategy. For example, Germany's Fraunhofer Institutes, Taiwan's ITRI, and Singapore's A*STAR have all launched initiatives that encourage the fluid transfer of ideas, innovations, and people across sectors. Our committee recognizes that we have made recommendations for increased support at a time when America has a large and growing budget deficit. However, as we emphasize in the report, we believe that research is an essential investment: there is

a deficit between what America is investing and what it must invest to remain competitive in innovation, scientific and health-care advances, and job creation.

Adding to the challenge is the fact that our government does not have good mechanisms to plan for reliable research funding over the long term or to provide capital for research infrastructure, new buildings and centers, and advanced research technologies. Additionally, the productivity of America's researchers has been crippled by policies that result in unnecessarily burdensome administrative tasks and piles of paperwork that take researchers' time away from their research. Recently, political interference in funding decisions has become a larger problem. There are also workforce challenges. Furthermore, a boom-and-bust pattern of NIH appropriations has produced a research enterprise larger than what the federal government will support. This has left many bright young scientists questioning their futures and many universities trying to rebalance their research portfolios. In short, we must not only invest, but also generate a framework in which this investment can thrive. The future of the nation's research enterprise depends on it.

Neal F. Lane:

I think it is fair to ask, "Why another report?" Many related studies on this issue have been conducted by reputable organizations, and many important reports have offered informed policy recommendations. But we felt strongly that the American Academy could add value to the conversation, specifically by focusing on the unique importance of research – basic research in particular – in all fields of science and engineering. I want to emphasize again Nancy's point that discoveries coming out of basic research – the search for fundamental knowledge – provide the foundation for applications to meet national needs. Investing in basic research offers high social and economic returns. Federally funded research at American universities, for example, supports the health of institutions that produce new knowledge and well-trained graduates that are clearly vital to the future of the country. And while U.S. industry makes it clear that companies depend on access to new knowledge and fresh talent to stay competitive in world markets, its investment in basic research – where specific product applications and sales cannot be foreseen – is often lacking. That is why the federal government must bear the principal responsibility for the support of basic research.

Restoring the Foundation includes three overarching recommendations and several policy actions that would support them. The first prescription argues for sustainable research funding with long-term goals. This is about money – what the federal government invests and how it makes investment decisions. As Nancy mentioned, while the U.S. commitment to basic research has vacillated since the early 1990s, other nations have learned from our past successes and are forging ahead. Our history shows, however, that sustainable funding is not impossible. For nearly twenty years, between 1975

and 1992, the federal investment in basic research followed a remarkably steady path, growing in real terms at over 4 percent a year, despite serious economic and political turmoil (for example, the 1973 oil embargo, the great inflation of 1979–1982, and the final years of the Cold War). Those investments are paying off right now in terms of the products, services, jobs, and economic gains that basic research has made possible. We argue that the United States needs to recommit to the importance of basic research and get funding back on track. We recommend specific short-range and long-range targets, which are made explicit in the report.

We also recommend several changes in the federal budget process. We highlight the value of multi-year appropriations. And while we realize that there are Constitutional limits on what Congress can do, change is still possible within the current state of law. For example, a rolling five-to-ten-year plan for the federal funding of

this end, we recommend several actions that can be taken by the funding agencies, the White House, the Office of Management and Budget, and universities to reduce wasted time and effort by researchers. Increasing efficiency would allow researchers to be more productive in their research and reduce unnecessary cost burdens on the universities themselves. Funding agencies also need to continue their efforts to address the plight of early-career researchers and to give proper weight to truly transformational ideas. But we emphasize that funding decisions of individual grants should continue to be based on expert merit-based peer review and managed by the funding agencies.

Our third prescription points to the need for a new and robust partnership between government, universities, and industry, which we might call Vannevar Bush II in reference to the man who designed the government-university partnership that was put in place at the close of World War II. Nearly seventy years after Vannevar Bush

educated and skilled workforce. For example, several universities are changing their approach to intellectual property in order to facilitate the translation of research discoveries to industrial applications, reduce university costs, and improve synergy with industry. We applaud those efforts and encourage other universities to reconsider their policies and change them where appropriate.

This is an abbreviated summary of our report. We would like to leave you with two key points. First is the argument for sustainable federal funding with special attention to long-term considerations; and second – perhaps even more important – is the imperative to ensure that those investments benefit the people who pay for them. The Academy, under President Jonathan Fanton’s leadership, is strongly supportive of the report, and we will all participate in every way we can to make sure these recommendations see actions.

In our report, we recommend policy reforms that would lower existing barriers preventing close cooperation between universities, national labs, and the companies that depend on them for new ideas, new technologies, and a highly educated and skilled workforce.

research and development could be released with the president’s annual budget request to Congress. In addition, a capital federal budget could be created for research infrastructure, which is common practice for corporations but something our government simply does not do.

Our second prescription is to ensure that the American people receive maximum benefit from the research they pay for. To

wrote his legendary *Science, the Endless Frontier*, the world is a very different place and the country needs a very different kind of partnership, one that may require some years to put together. In our report, we recommend policy reforms that would lower existing barriers preventing close cooperation between universities, national labs, and the companies that depend on them for new ideas, new technologies, and a highly

The Alternative Energy Future



Barbara Kates-Garnick

Barbara Kates-Garnick is the former Massachusetts Undersecretary of Energy. She is currently Professor of Practice and Director of the Energy, Climate, and Innovation program at the Fletcher School of Law and Diplomacy at Tufts University. She is a member of the Advisory Committee of the Academy's Alternative Energy Future project.

First, I would like to acknowledge Maxine Savitz and Robert Fri, who cochair this project.* They are playing a critical role in helping us understand the transformation of our physical energy infrastructure and our opportunities for an alternative energy future.

The earth is warming. Its surface temperature has risen by 1.4 degrees centigrade over the past century and is projected to rise further: between 2 and 11 degrees centigrade over the next hundred years. A global temperature rise of 2 degrees centigrade has been considered the upper limit for a “safe” temperature rise: anything higher and we risk seeing the dangerous impacts of cli-

Social science will play a vital role in our energy future, because we must contend with the economic and social challenges of transitioning technology.

mate change. Recently even that threshold has been deemed too high.

Our energy numbers, however, do not reflect the gravity of the climate change reality. In 2012, U.S. electricity production came mainly from fossil fuels and generated over 32 percent of our greenhouse-gas emissions. The transportation sector contributed 28 percent to emissions that year, mainly from gasoline and diesel. Given that these two sectors together make up over half of our emissions, they need to become the focus of change in terms of alternative technologies, economics, and behavior if we are to slow down global warming within a reasonable timeframe.

An alternative-energy project, at this point, should be focused on innovations to our physical energy system, and the behavioral and policy designs that are needed to adapt to a transforming energy infrastructure. It seems very difficult for us to change systems, regulatory paradigms, and behavior to deal with a problem that affects vested interests, is global in its impact, and is likely to intensify over time. All of these factors have made the development of an international climate regime extremely complex – hence the need for this Alternative Energy Future project.

We must change how energy is produced, delivered, and consumed. Energy is delivered instantly to our homes and businesses through a massive infrastructure that was built on technological innovation and continues to evolve. Now, however, we must find new technological innovations. Renewable energy is gaining market share and achieving parity with fossil fuels, but integrating an intermittent resource (such as

renewables) into the power grid is complex, and we must determine how to maximize the value of such resources while reducing our use of fossil fuels.

We can also educate consumers about energy efficiency practice, which is equivalent to any other resource. These efforts will limit the growth of power plants. But customers also need to see real-time price signals that will change their behavior in a meaningful way. We are also entering the world of distributed generation, where solar energy and other technologies permit consumers to produce energy on site and even to separate themselves from the grid entirely through smaller energy systems called microgrids.

All of these are complex technologies, and integrating them is absolutely necessary to making progress toward a sustainable energy future. At the same time, there remains a very essential role for social science, because we must contend with the economic and social challenges of transitioning technology. We can anticipate and plan for disruptive change, but participants in our project also point out the need for smooth transitions and changes that are adaptable and durable. These are very important concepts: in the highly transparent and communicative world in which we live today, failure is not an option. Think of the times when your power goes out: you cannot get to your computer, so you cannot do your work. The American workforce depends more than ever on being connected to the energy grid, so reliability must be a critical aspect of any development we make.

So, rather than developing a framework in an analytical silo, focusing only on one

* The Academy mourns the passing of Robert Fri (November 16, 1935 – October 10, 2014).

Public Understanding of Science & Medicine: Public Trust in Vaccines



Seth Mnookin

Seth Mnookin is the author of The Panic Virus: The True Story behind the Vaccine-Autism Controversy, among other books. He is the Associate Director of the Graduate Program in Science Writing at the Massachusetts Institute of Technology and Cochair of the American Academy's Public Trust in Vaccines project.

Today I will very briefly discuss the history of scientific advances in medicine and the social reaction to those advances in the past one hundred and fifty years. Then I will tell you about the Public Trust in Vaccines project, which I cochaired with Barry Bloom and Edgar Marcuse.

Vaccines, along with antibiotics and clean drinking water, are one of the three advances in medicine and public health that most dramatically changed the way we live in the world. If you look at the average American lifespan over the past century, you can see a remarkable jump of several decades. That is not due to people living longer per se, but rather to people not dying at very young ages of preventable conditions. We went from an average longevity of about fifty years to about seventy. This

is not because all of a sudden fifty-year-olds were living for twenty more years, but because far fewer children were dying. One of the main reasons for that is the development and use of vaccines.

The effect of vaccines has been felt most strongly in industrialized and Western nations; among those, the effect has been strongest of all in the United States because of our mandatory school-age vaccination laws, which do not exist in the U.K. and much of Western Europe. But the effects of vaccines actually extend far beyond public health. For example, if you look at the prevalence of vaccines over time juxtaposed with other social trends, you can see a stark correlation between women in the workplace and the number of vaccines that had been introduced. When mothers no longer had to spend weeks or months of every year quarantined with their children, many more women were able to go to work.

Fast-forward to the end of the twentieth century: Over the past fifteen years, there has been a series of vaccine-related scares – in the United States, the U.K., and to some extent in Western Europe – that have largely originated from assorted frauds and charlatans, but have gained real traction because of parent-activist groups. These groups are, for the most part, very well-meaning, although they are mistaken in their fears. In retrospect, the public-health apparatus was completely unprepared to deal with these scares. In the late 1990s and early 2000s, we were still primarily operating in a paradigm in which doctors gave authoritative recommendations and patients followed them. But patients were no longer relying solely on medical authorities for information about their health, and to some extent, these vaccine-related panics were related to the way public health authorities communicated to the public. When, for instance, the United States decided to recommend removing a mercury-based preservative from vaccines

We have drawn attention to an urgent need for more research into the science of science communication. The way we interact with science will have very dramatic effects on the future of our society.

in the late 1990s, the CDC released a statement saying that the decision was made despite there being “no evidence of harm.” Many parents interpreted this statement to mean that there was *about* to be evidence. The American Academy of Pediatrics said, “We’re going to make safe vaccines even safer.” Well, if parents are told something is safe, they do not assume that it will be on a sliding scale.

Over the past decade, we have seen overall vaccine-uptake rates in this country remain fairly high. But at the same time, we have seen concentrated pockets of under-vaccination around the country. Especially in the past five or six years, we have started to see some significant effects of under-vaccination, most notably in a series of measles outbreaks. The past several years have seen the largest number of measles outbreaks since the mid-1990s. This is especially remarkable because the World Health Organization declared in the year 2000 that measles had been eliminated from the United States. We are now seeing a resurgence of a disease that was completely eliminated. That is so crucial partly because, according to a study about a 2008 measles outbreak, containing and treating each individual case cost public health providers more than \$10,000. When the number of cases climbs to a couple of hundred or a couple of thousand, the costs become very high.

The American Academy became interested in this very salient issue and convened a committee to examine it. The three cochairs of the project – Barry Bloom, Edward Marcuse, and I – felt that instead of discussing our intuition about which strat-

egies would best address vaccine hesitancy, we needed evidence-based research that provided clear answers.

Our committee, which included individuals from the CDC and the National Vaccine Program office, gathered together in 2013 at the Academy. The result was the *Public Trust in Vaccines* report, which defines a research agenda. We found three areas that we thought especially needed attention: parental attitudes and knowledge; the events of the medical encounter; and specific issues regarding at-risk communities. Responses to this report have been extremely positive; we received attention from *Science* magazine and a request from the CDC for a briefing. We have drawn attention to an urgent need for more research into the science of science communication. Trust in science and scientists is dropping; depending on how you measure it, it may actually be at an all-time low. As we have heard already in this panel, the way we interact with science will have very dramatic effects on the future of our society. I appreciate the Academy’s support for the project, which I believe sends a hopeful signal that faith in the usefulness of this type of research remains.

Global Security & International Affairs

Committee on International Security Studies



Steven E. Miller

Steven E. Miller is the Director of the International Security Program at the Belfer Center for Science and International Affairs at the Harvard Kennedy School. A Fellow of the Academy since 2006, he is the Cochair of the Academy's Committee on International Security Studies and Codirector of the Academy's Global Nuclear Future Initiative. He also serves as a member of the Academy's Council.

First, let me begin by congratulating the new inductees. I can personally attest that if you embrace the opportunity that the Academy represents to advance your personal and professional agenda, then the honor being bestowed on you today has the potential to alter the trajectory of your work and be a truly life-changing event.

We thought it might be interesting to begin by providing you with a snapshot of the origins and evolution of the Committee on International Security Studies. In 1958, the Committee on Arms Control was founded here at the Academy. Its intellectual history can be traced to a public appeal made by Albert Einstein and Bertrand Russell in 1955 that called attention to the dan-

Since the American Academy's Committee on Arms Control was formed in 1960, the Academy has always had a standing body devoted to addressing arms control and international security.

gers of nuclear weapons and warned of the "species-threatening nature of nuclear technology." It has become known as the Russell-Einstein Manifesto and was Einstein's last public act.

This notion was picked up by a Canadian-American industrialist named Cyrus Eaton, who had made his fortune in railroads. He funded the first meeting of Soviet and Western scientists in 1958 in his home village of Pugwash, Nova Scotia. The meeting was intended to try to bridge the chasm that existed between the Soviet and the Western world. Partially thanks to this meeting, the intellectual construct began to emerge that even enemies share a common interest in avoiding mutually annihilating nuclear catastrophe; that managed competition, however intense, would be preferable to unconstrained rivalry. This led to a fundamental question: how can we collaborate with our bitterest enemy in order to minimize the nuclear instabilities and dangers that menace us both? Up to that point, any reference to disarmament had been largely rhetorical, coming in the form of grand pronouncements proclaiming "our great fidelity to general and complete disarmament." But after the Russell-Einstein appeal gave rise to a more sober interest in de-escalation, the challenge was to craft a meaningful policy approach to pursue these goals, and so the American Academy's Committee on Arms Control was formed. Among the participants were Academy Fellows Henry Kissinger, Thomas Schelling, and Paul Doty. Out of the Committee's work emerged two issues of *Daedalus* that were later republished as an edited volume under the title *Arms Control*,

Disarmament, and National Security, which became the so-called bible of arms control. It also led directly to the production of a small book by Thomas Schelling and his then-graduate student Morton Halperin called *Strategy and Arms Control*, which is also a classic in the disarmament literature.

Since that first committee was formed, the Academy has always had a standing body, under various names, devoted to addressing arms control and international security. In the 1980s, it was heavily involved in the debate over missile defense spawned by President Reagan's Star Wars initiative. In the 1990s, the Academy played a significant role in addressing questions of sovereignty and intervention, which were catalyzed by the Balkan crisis and by the emergence of the notion of responsibility to protect (which suggested that the international community had not only a right but an obligation to intervene on behalf of threatened peoples). More recently, the Academy has spearheaded a series of significant projects on corruption and international security. Professor Robert Legvold of Columbia University led a project on ordering the post-Soviet space, which looks particularly prescient now. John Steinbrenner of the University of Maryland has recently completed a project under the auspices of the Academy examining the question of governance of the human exploration of outer space. We are pleased that the Academy continues to maintain its historical role as a leading voice on international arms control and security.

New Dilemmas in Ethics, Technology & War



Scott D. Sagan

Scott D. Sagan, a Fellow of the Academy since 2008, is the Caroline S.G. Munro Professor of Political Science at Stanford University and a Senior Fellow and former Codirector of Stanford's Center for International Security and Cooperation. For the past six years, he has also been the Codirector of the Academy's Global Nuclear Future Initiative.

This panel will be discussing two projects: Ethics, Technology, and War and the Global Nuclear Future. I will begin by discussing the intersection between them. Just after the bombing of Hiroshima and Nagasaki in 1945, *Fortune* magazine published the results of a poll that asked Americans their opinions about the attacks. More than 53 percent of the public expressed approval for the bombing and 13 percent wished that there had been a demonstration strike on an unpopulated area first. What was most surprising was that 22.7 percent said that the U.S. government should have dropped many more bombs before giving Japan a chance to surrender. I used to think that this support for what could be called “atomic retribution” had to be understood

in the context of Pearl Harbor, the massacre at Nanking, and the Bataan Death March, all of which were fresh in the public consciousness. However, recent research has suggested that something more disturbing was displayed in this 1945 poll.

In 2013, my colleagues Benjamin Valentino, Daryl Press, and I published the results of a survey experiment in which we asked a representative sample of the American

public views the potential use of nuclear weapons against an enemy in a very positive light, and that there is much less of a taboo around using nuclear weapons today than was previously assumed.

This raises important questions about the degree to which key principles of just-war doctrine, such as noncombatant immunity and proportionality, have been integrated into American public opinion. As you have

We are looking at important questions about the degree to which key principles of just-war doctrine, such as noncombatant immunity and proportionality, have been integrated into American public opinion.

public to read a hypothetical story in which Al-Qaeda was suspected to be building a primitive nuclear device in a cave in a neutral country. After reading the story, the public was asked whether they would approve of the United States using nuclear weapons to attack that site, given a certain probability that such a nuclear strike would effectively destroy the target. With different groups of subjects, we then varied the effectiveness of a nuclear strike versus a conventional strike against the Al-Qaeda cave. What surprised us was that 18.9 percent of the public preferred using nuclear weapons, even when it was clear they were not needed, because a conventional strike was posited to have the same 90-percent probability of destroying the Al-Qaeda cave. When, with other groups of respondents, we increased the efficacy of the nuclear strike to 90 percent and reduced that of the conventional strike to 70 or 45 percent, numbers of individuals preferring or supporting nuclear strikes rose dramatically. Although further research on this topic would be most helpful, our results suggest that a significant portion of the U.S.

heard, the Academy has had a long and distinguished tradition of dealing with nuclear issues and arms control. It has a slightly less lengthy but no less distinguished tradition of addressing ethical issues. In 2000, the American Academy published *The United States and the International Criminal Court*, a volume edited by Carl Kaysen (distinguished economist, former government official, and longstanding Cochair of the Committee on International Security Studies) and Sarah Sewall (then at the Harvard Kennedy School, and now the Under Secretary for Civilian Security, Democracy, and Human Rights). And, in 2003, an entire issue of *Dædalus* was published in which philosophers, political scientists, lawyers, and economists addressed challenges with global justice.

A new Academy project is gathering together a diverse group of individuals – including scholars, soldiers, and diplomats – interested in different aspects of just-war theory and application, and the challenges that modern technology creates. We put together the New Dilemmas in Ethics,

New Dilemmas in Ethics, Technology & War

Technology, and War project to analyze questions about ethics and justice before, during, and after modern wars. We are also asking ethical questions about which technologies are helpful and which create major challenges, whether it is weaponry (such as drones and biological weaponry), technologies for providing early-warning capabilities (such as satellites and expanded cell-phone usage), or medical technology improvements (which may reduce the mortality rate of soldiers or civilians in war, but could create new issues concerning higher numbers of wounded people after conflicts). Advanced weapons systems, for example, have led to optimism about the possibility of reducing collateral damage in war, but they have concurrently raised concerns about whether states now find it too easy to use force. This is a very new project, and we do not yet have the answers to these questions. But I do believe we are asking the right questions.



Janne E. Nolan

Janne E. Nolan is a faculty member at the Elliott School of International Affairs at George Washington University, where she chairs the Nuclear Security Working Group. She is also a long-serving member of the Academy's Committee on International Security Studies.

Issues of ethics in national security and in war in the twenty-first century go straight to the heart of the question of the strategic imperatives of American engagement.

The question of the legitimacy of American operations is not a nonessential matter: public perception of the legitimacy of our engagement and methods is an absolutely essential and critical ingredient in their success and effectiveness.

The question of the legitimacy of American operations is not a side note or a non-essential matter, as has been suggested by some academics and practitioners. Public perception of the legitimacy of our engagement and methods is actually an absolutely

essential and critical ingredient in their success and effectiveness.

My contribution to this larger project relates to the paradoxical but systemic tendency in the United States to underestimate – and often misconstrue – the nature and costs of the wars and engagements into which we enter. There is also a persistent pattern in U.S. military engagements of operating with a flawed conception of the conditions on the ground and then trying too late to adjust to the miscalculations. Where does that come from? We are working with individuals doing case studies of situations in which such discrepancies existed between a caricatured prediction of the engagement and its reality. This falls directly into larger questions about just war. What do we do when our civilian leadership is wrong and misinformed or marginalizes available information? Indeed, in many of the case studies that we have explored so far, we have found a common tendency to marginalize not only complex information, but also information that is discordant with the core assumptions that are driving a push to intervene. This constitutes an interruption in the flow of information and an interruption in the marketplace of ideas that often produces catastrophic and dire consequences. These

are first borne by the military and then, subsequently, by entire societies.

The interdisciplinary study that Scott Sagan conducted and described so well is precisely the type of analysis we should be doing. This analysis, however, often results

The Global Nuclear Future

in a conversation that unfortunately rarely happens in Washington, where there are dramatic divisions between discussions of strategy, humanitarian intervention, and ethics. It is very infrequent that all of these threads are brought together, but it is our goal to do so, and in the process explore sensitive but vital questions. One is civilian accountability and leadership accountability: we have a greater understanding about military command authority and responsibility, but we have comparatively very little on the side of civilian leadership. The second under-addressed factor we will explore is education: it is fundamental to teach people to be more critical thinkers, particularly in the area of national and international security. After the 2003 invasion of Iraq, many studies concluded that particularly intelligent people had a failure of imagination and failed to speak truth to power about the invasion. What the studies may have overlooked is the fact that the consequence of speaking truth to power is often professional ruination. We want to address this issue as well, and encourage unbiased research that cuts across disciplines to contribute to a healthier policy debate about war.



Robert Rosner

Robert Rosner, a Fellow of the Academy since 2001, is the William E. Wrather Distinguished Service Professor in the Departments of Astronomy and Astrophysics and Physics at the University of Chicago. He is a former head of the Argonne National Laboratory. He is also the founding Codirector of the Energy Policy Institute at the Harris School of Public Policy at the University of Chicago. He is a member of the Academy's Council and serves as Codirector of the Academy's Global Nuclear Future Initiative.

The Fukushima Daiichi nuclear disaster and its aftermath have given the United States a new perspective on the global nuclear future. Certain other countries have also clearly taken note of the significance of the disaster, the most prominent example probably being Germany. But the majority of the world has seemed relatively unperturbed by this event. In fact, there is considerable evidence that a growing number of countries have a burgeoning interest in nuclear power. Consider, for example, the United Arab Emirates; in particular, Abu Dhabi. One might think that it would have enough fossil fuel to last a good while for energy pro-

duction and desalination. But, in fact, four nuclear plants are being built there.

We have focused on the issue of how to cope with this expansion – and encourage safe, secure, and sustainable management of nuclear power – when much of it is happening in nations that may be unprepared, both technologically and in their human infrastructure, to deal with its consequences. Our focus has primarily been on the Middle East and Southeast Asia. Specifically, we have engaged with the so-called nuclear newcomers – Vietnam, the United Arab Emirates, Turkey, Jordan, and Malaysia – and, also important, legacy countries such as Japan and Korea. Why Japan and South Korea? Both countries have a classic problem of legacy countries: namely, storing nuclear waste. Bringing legacy countries (which are better-poised and highly incentivized to deal with nuclear waste) to the same table as the nuclear newcomers is important to the success of our ongoing projects related to the back-end of the nuclear fuel cycle (spent-fuel storage and disposal). These include thinking about how we might coordinate across national lines to better internationalize and regionalize nuclear-waste storage; strategizing about removing nuclear materials from plants and across national borders; and developing a better understanding of the economics of dealing with nuclear waste in the international context. In addition to the back-end of the fuel cycle, we have also been focusing on nuclear safety, nuclear liability, and nuclear terrorism – in particular, the issue of insider threats.

One thing that we recognized early on is that it is not a great idea to tell other people what to do. The individuals and groups that we deal with are already very savvy about the problems associated with nuclear energy. A very important element of our approach, therefore, has been to involve the stakeholders in the countries that we are vis-

iting in the discussions. In fact, many of our publications are authored or coauthored by individuals from the countries we have been working with: we are not the only ones at the table speaking.

Much of the work in the area of nuclear security has historically focused on what I like to call the “utopian state.” This work often founders on the problem of how we

We have focused on the issue of how to encourage safe, secure, and sustainable management of nuclear expansion in nations that may be unprepared, both technologically and in their human infrastructure, to deal with its consequences.

get to the world as we would like it to be. With this in mind, we have recognized the need to focus on the process of “getting there.” What does this mean in practical terms? We have been convening regional conferences with key stakeholders: civic leaders, politicians, academics, and individuals in the private sector and in industry. We have also been hosting policy briefings, consulting with government officials in various countries, and facilitating the involvement of the international nuclear industry in the conversation. We have commissioned publications coauthored by stakeholders in the regions we have visited, as I mentioned before; we have also been fostering relationships with the academic community in those regions.

Our work has led to the publication of two issues of *Dædalus* and a number of occasional papers on topics ranging from disarmament and nonproliferation to the back end of the nuclear-fuel cycle and the nature of reactors themselves.

Of our three publications from the last year, only one of them was written by one of us (this was an occasional paper coauthored

by Scott Sagan and Matthew Bunn, called *A Worst Practices Guide to Insider Threats: Lessons from Past Mistakes*). The other two were written by experts from our target regions. For example, an entirely new subfield in nuclear security studies was explored by Mohit Abraham, a constitutional lawyer in India, who wrote for us about India’s changing perspective on nuclear liability.

Liability has generally been placed on the operator, and, by extension, on the government to provide backstop. India is now considering extending liability to the companies that actually produce the equipment. You can imagine the reaction of the nuclear industry to that change.

2014 was a very busy year for our program. We had a meeting in Bali to which we invited stakeholders from all the ASEAN countries, as well as Japan, Korea, and China. We ran a workshop on insider threats here in Cambridge, Massachusetts. We also held a workshop for journalists in the Middle East, discussing nuclear-related issues the region faces. The *Worst Practices Guide to Insider Threats* has actually become a training manual at United States weapons labs, which was surprising and excellent news. That publication was also highlighted at the World Institute for Nuclear Security (WINS) workshop in Vienna in September 2014. The work I have been guiding on the back-end of the nuclear fuel cycle has led to discussions with the U.S. State Department and nuclear industry leaders.

We traveled to Abu Dhabi in January 2015, primarily to follow up on our first meeting. During that previous visit, the government was deciding which corporate team would design and build their plants; now the chosen team, led by a South Korean group, is actually in the process of building them. We will be in Seoul in February; in Chicago in March; and finally, in May, participating in the Non-Proliferation Treaty Review Conference. Finally, we will be participating in an international conference on insider threats when we release our book on the subject. It is a busy schedule, but we have a great time.

I would like to end my remarks by repeating Steven Miller’s sentiment: the Academy is a great venue to do interesting things. It has amazing pulling power to engage the world in ways that we – sitting in our academic institutions – often do not, so I highly encourage you to participate.

Humanities, Education & Social Policy

The Commission on the Humanities & Social Sciences



Carl H. Pforzheimer III

Carl H. Pforzheimer III, a Fellow of the American Academy since 2002, is Treasurer of the Academy and the Manager of Carl H. Pforzheimer & Co. LLC and of CHIPCO Asset Management, LLC. He is a member of the Academy's Commission on the Humanities and Social Sciences. He serves as a member of the Academy's Board of Directors, Council, and Trust.

In 2010, a bipartisan group of Congressional leaders called upon the Academy to examine the importance of the humanities and social sciences to American democracy and competitiveness. They asked the Academy to consider this question: "What are the top actions that Congress, state governments, universities, foundations, educators, individual benefactors, and others should take now to maintain national excellence in humanities and social-scientific scholarship and education, and to achieve long-term national goals for our intellectual and economic well-being, for a stronger, more vibrant civil society, and for the success of cultural diplomacy in the twenty-first century?" To address this question, the Academy in 2011 established the Commis-

The Humanities Commission brought together leaders from disparate fields to advance a new conversation about the importance of the humanities to the nation's intellectual and economic strength, its public institutions, and its civil society.

sion on the Humanities and Social Sciences. The Commission brought together leaders from the sciences, business, public affairs, social sciences, humanities, and the arts to advance a new conversation about the importance of these disciplines to the nation's intellectual and economic strength, its public institutions, and its civil society.

The Commission's report, *The Heart of the Matter*, was released on June 19, 2013. The Commission was chaired by Richard Brodhead, President of Duke University, and John Rowe, Chairman Emeritus of Exelon Corporation; it included fifty-two other leaders from academia, business, the arts, and public affairs. As part of the rollout of the report, the Commission oversaw the creation of a companion film created by Ewers Brothers Productions in consultation with two Commission members, Ken Burns and George Lucas. The film has been viewed over thirty thousand times online and screened at large meetings across the country, even in K–12 classrooms.

The goal of the Commission was to push the public conversation about education to reintroduce the humanities and social sciences into a dialogue that had been focused almost entirely on the STEM disciplines. To that end, approximately one hundred thousand copies of the report have been distributed in hard copy or downloaded from the website. *The Heart of the Matter* has been the subject of dozens of op-eds, including fifteen by Commission members. Nearly three hundred articles have been written about the report. Many other major news outlets,

including *The New York Times*, *The Atlantic*, *Slate*, the *Huffington Post*, NPR, and PBS, have covered the Commission's work in detail – Richard Brodhead even had a memorable appearance on *The Colbert Report*.

Commission members and American Academy staff are working with the Federation of State Humanities Councils and the Institute of Museum and Library Services to sponsor *Heart of the Matter* events in at least fifteen states. In fact, we are working with anyone who is interested in meaningfully extending the dialogue. We even structured the Commission website to mirror the sites of political campaigns so that visitors can quickly and easily request materials and register for email updates.

Policy-makers have taken note of our activities. In January 2014, six Senators and six Commission members met for dinner in Washington, D.C., to discuss next steps. Since then, members of both the House and the Senate have expressed interest in pursuing some of our recommendations, most notably those on international education. For example, in December, Representative Rush Holt of New Jersey suggested an expansion of President Obama's proposed STEM Master Teacher program to include other disciplines in addition to math and science, based on a recommendation from *The Heart of the Matter*. In fact, the first page and a half of the bill was lifted directly from the Commission report.

I suspect that part of the Commission's success will be due to the expanding network of partnering organizations working

The Commission on the Humanities & Social Sciences

to push the Commission agenda forward. These include the National Humanities Alliance, the Federation of State Humanities Councils, Phi Beta Kappa, the American Association of Universities, the Association of American Colleges and Universities, and the Chicago Humanities Festival, as well as colleges and universities across the country. Earlier, Robert Rosner made a comment about preaching to the choir, which is something about which the Academy remains mindful in its endeavors. I would say that, although all of the organizations that I just mentioned are part of the choir, there are many more concerts being planned than ever before.



Karl W. Eikenberry

Karl W. Eikenberry, a Fellow of the Academy since 2012, is the former United States Ambassador to Afghanistan and retired U.S. Army Lieutenant General. He is currently the William J. Perry Fellow in International Security at the Center for International Security and Cooperation and a faculty member of the Shorenstein Asia-Pacific Research Center at Stanford University. He is a member of the Academy's Commission on the Humanities and Social Sciences.

The Charter of the American Academy of Arts and Sciences, written in 1780, says that “The end and design of the institution is to cultivate every art and science that may tend to advance the interest, honor, dignity, and happiness of a free, independent, and virtuous people.” I think that this very aptly describes what the *Heart of the Matter* report has done in promoting the study, research, and practice of the arts, humanities, and social sciences in the United States.

One of the most unusual aspects of this report is that, unlike most, it was not prepared, issued, and then promptly put on everyone’s shelf. Instead, it has truly served

as a starting point for an ongoing national conversation about the issues that it raises and the possibilities that it explores. I have had the honor of serving on this Commission and have contributed to several events since the publication of the report over the past eighteen months, including at the National Humanities Alliance annual meeting in 2013; Carnegie Mellon University; the Chicago Humanities Festival; the British Academy of Humanities and Social Sciences in London; and a gathering at North Carolina State University that was attended by the Chancellor of the University, the Duke University president, and Congressman David Price. Truly, each one of these experience has been among the most rewarding of my life.

Let me offer three thoughts, then, to those of you who may be interested in contributing to this enterprise.

First, in terms of considering the comparative advantages each one of you might have to offer, it is useful to think in terms of the project’s overarching goals. These include: educating Americans in the knowledge, skills, and understanding they will need to thrive in a twenty-first-century democracy (this is very much in the tradition of Judge Louis Brandeis’s famous maxim that the most important political office in this country is that of private citizen); fostering an innovative, competitive, and strong society; and preparing the nation to lead in an interconnected world.

Second, the report’s areas of emphasis are very comprehensive and offer the possibility for any Academy Fellow to engage in areas corresponding to his or her strengths and interests. This could be K–12 education; two- and four-year colleges; research; cultural institutions and lifelong learning; or international security and competitiveness. Given my own background in the military and diplomacy, I have elected to focus my public presentations primarily on the last

topic: maintaining the nation's leadership in a globally interdependent world.

Third, and last, some specific recommendations:

Let the Committee – in particular, Program Director John Tessitore – know of your desire to contribute if you wish to do so. John does a terrific job of letting Fellows know about events of possible interest either nationally or in their own backyard.

Look for opportunities to create events, either in collaboration with others or on your own.

whether taking courses in literature, drama, and philosophy would help them in making a living in the United States of America today and over the next several decades.

Draw upon your own life experiences in making your arguments. When I speak publicly, I discuss the advantage that my years of liberal arts education at West Point, Harvard, and Stanford provided me during my military and diplomatic career. I talk about the importance of my Chinese language studies and about the many skills I acquired as a result of my arts and humanities cur-

Report than in Afghanistan! So you must get outside of your comfort zone if you want to reach the younger generation.

It is important that we engage with scientists, engineers, and mathematicians; businesspersons; and those in the executive and the legislative branches at federal, state, and municipal levels.

As two other speakers mentioned today, it is important that we do not waste time lecturing the converted, but instead engage with scientists, engineers, and mathematicians; businesspersons; and those in the executive and the legislative branches at federal, state, and municipal levels. And you'll usually find very receptive audiences among those individuals.

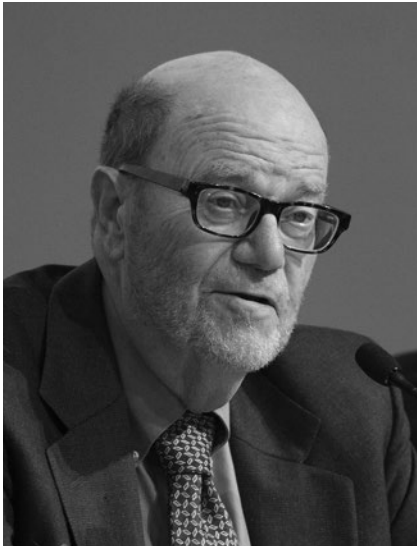
Include instrumentality in your arguments for the arts and humanities. Of the top leaders of one major Silicon Valley IT company, eight majored or minored in the arts or humanities either as undergraduates or graduate students. The list includes a music major, a drama major, a dance minor, and an individual with a master's degree in philosophy from Oxford University. It is important that our Committee continues to enlist individuals whose professional success was helped by their humanities background and to make their voices heard. This is crucial because parents and children in our country are very concerned about

riculum: analytical thinking; a rigorous grounding in ethics, writing, creativity, and problem solving. I also talk about my time as an ambassador in Afghanistan, where some of our most cost-effective development programs were focused on the arts and humanities. For example, one of our most valuable staff members was the embassy archaeologist, who led two projects in Afghanistan to help rebuild the Afghan National Museum and restore the famous Citadel of Herat in Western Afghanistan. Recounting vignettes such as these can be very powerful.

Use the Academy resources. *The Humanities Report Card* and reports on government and private expenditures in the arts and humanities are available online.

Finally, recognize the need to communicate in ways that reach today's younger generation. As you heard, Duke University President Richard Brodhead had a superb appearance on *The Colbert Report*. I told him at the time that I thought it was probably tougher volunteering for duty on the *Colbert*

The Humanities Indicators



Norman M. Bradburn

Norman M. Bradburn is a Senior Fellow at the National Opinion Research Center (NORC) at the University of Chicago, and the Tiffany and Margaret Blake Distinguished Service Professor Emeritus in the faculties of the Department of Psychology, the Harris School of Public Policy, the Booth School of Business, and the College at the University of Chicago. He was elected a Fellow of the Academy in 1994. He is the Principal Investigator of the Academy's Humanities Indicators Project.

In 1997, the American Academy of Arts and Sciences began exploring the feasibility of a Humanities Indicator project that would publish up-to-date data on the humanities in the United States. With generous support from the Andrew W. Mellon Foundation, work on a prototype of the Indicators began in 2006, and the project became fully operational in 2008. The Humanities Indicators takes as its model the long-running Science and Engineering Indicators released by the National Science Foundation. The Science and Engineering Indicators have become the gold standard for data underlying an array of policy debates and have driven

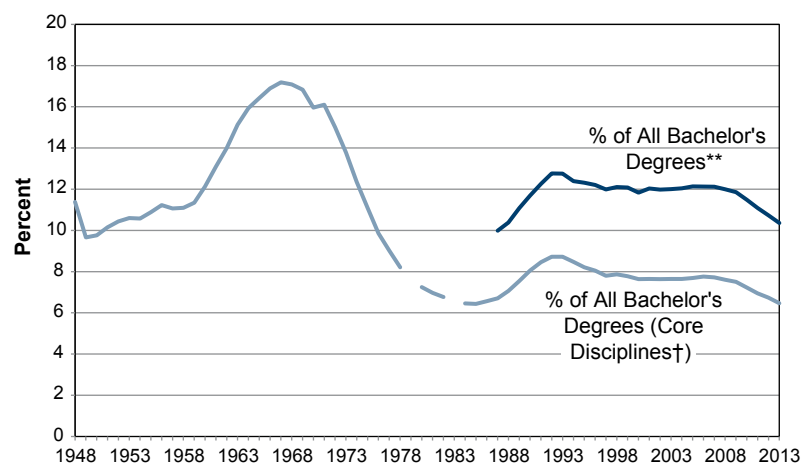
The Humanities Indicators afford us the ability to examine things to which little public attention has been paid, allowing us to better inform our discussion about the current health of the humanities.

much of the conversation over the past two decades about the needs of the STEM community. The need for a humanities equivalent was apparent.

What do we mean by Humanities Indicators? Indicators are quantitative, descriptive statistics that chart trends in some phenomena of interest. They are policy-

neutral and are updated regularly. They describe a situation but do not explain anything. They answer “what” questions, not “why” questions, so their interpretation is not always straightforward; their data may mean different things to different observers. If done well, they provide a reference against which arguments for changes in

Bachelor's Degree Completion in the Humanities, 1948 – 2011



** Represents “core disciplines,” plus other humanities disciplines based on the National Center for Education Statistics’ Classification of Instructional Programs.

† “Core disciplines” here denote English, foreign languages, history, and philosophy.

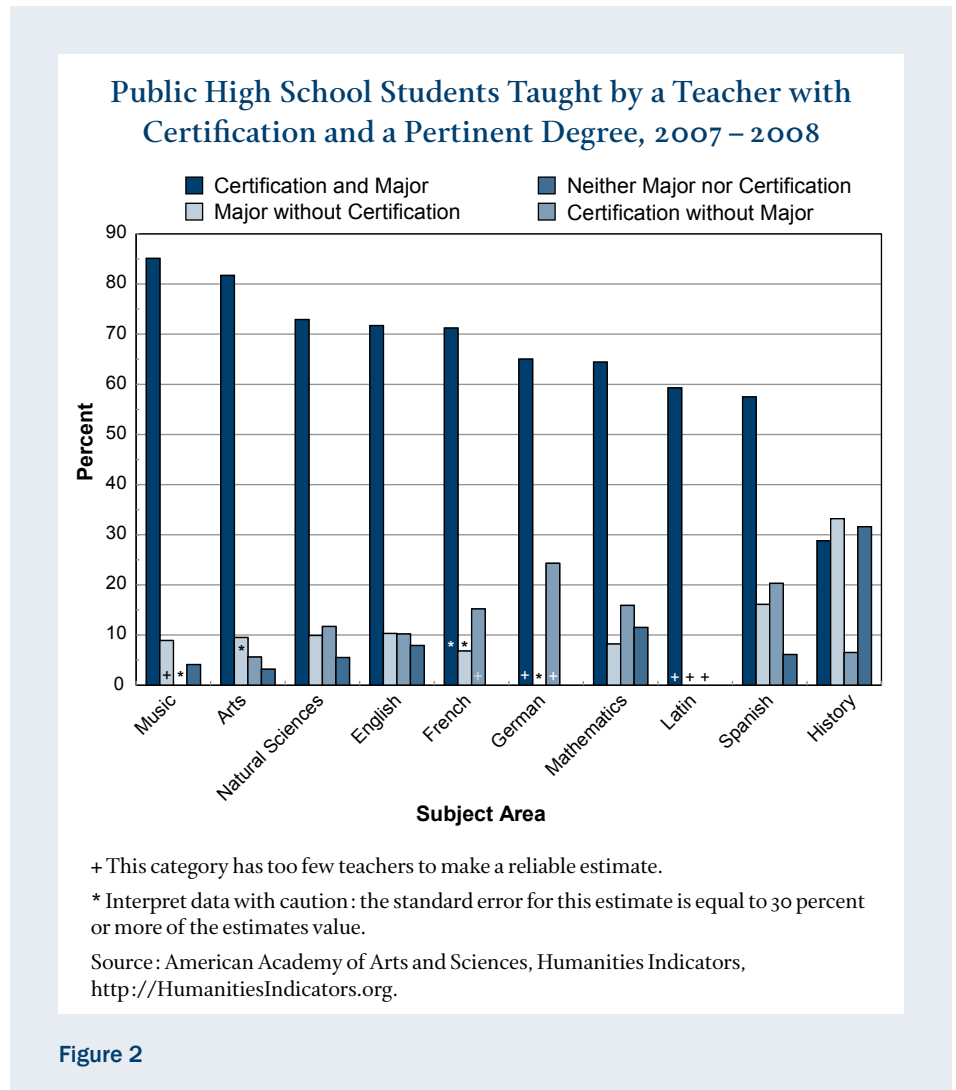
Source: American Academy of Arts and Sciences, Humanities Indicators, <http://HumanitiesIndicators.org>.

Figure 1

reality can be tested, and a common starting point for arguments about the nature or rate of change in some phenomenon of interest.

What questions about the humanities do we need answers to? We posed this question to people active in various aspects of the humanities. For many of these questions, we have no answers at present due to a lack of data. However, we were able to distill the many viable questions down to a manageable set of five topics. These topics are: primary and secondary education; undergraduate and graduate education; research and funding for the humanities; the humanities workforce; and humanities in American life. The Indicators site currently contains 76 topics and over 270 graphs and tables of information organized by these five categories. The website is updated regularly as new information becomes available.

The Indicators have been heavily used, sometimes leading to vigorous controversy. For example, Harvard University used our data last year in a report on the humanities. *The Wall Street Journal* picked up that data and created a graph to start a conversation about the collapse of the humanities as signaled by the number of majors. But if you look at the data closely, you will see that the dramatic decline they trumpeted occurred in the 1970s and 1980s (see Figure 1). The gradual decline that has taken place over the past four decades is interesting, but humanities majors only dropped one percentage point after the onset of the 2008 recession – hardly a sudden collapse. Furthermore, the peak from which the humanities fell in the 1970s was an unusually high point of engagement. The graph used by *The Wall Street Journal* and Harvard left out a second line (shown in dark blue in Figure 1), which represented our attempt to account for students in other disciplines that certainly count as

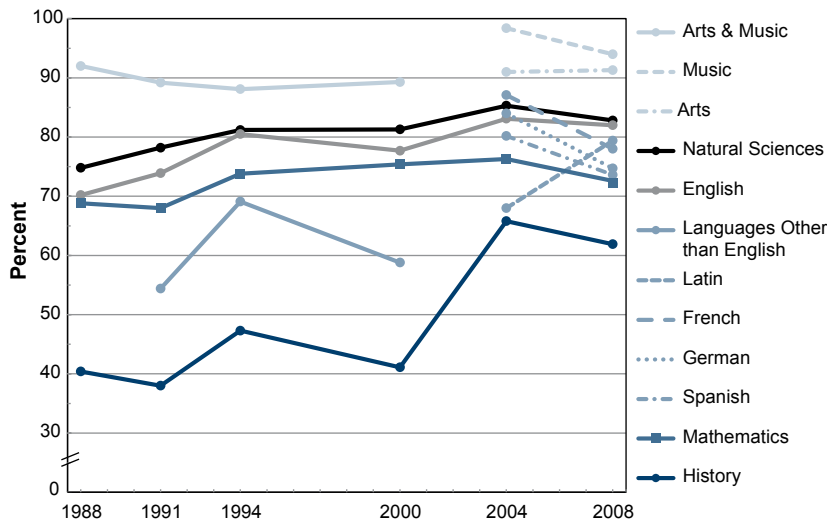


the humanities (such as area studies) but which are outside of the “core of four” humanities disciplines (English, foreign languages, history, and philosophy).

The Indicators can also tell interesting stories by drawing comparisons between the humanities and other fields. For example, when we look at the number of humanities courses taken by those majoring in different subjects and compare that with the number of STEM courses taken by various majors, we see several interesting things. First, across

all majors, more humanities courses are taken than STEM courses. Secondly, majors in STEM subjects take more humanities courses than humanities students do STEM courses. We have also seen that students in a few areas, such as engineering, have very little ability to take humanities courses. This conclusion is supported by data showing that at colleges of engineering, colleges of education, and other highly specialized institutions, extensive requirements make it hard to take lots of humanities courses.

Public High School Students in Classes Taught by a Teacher with an Undergraduate or Graduate Major in that Subject Area, 1988 – 2008



Source: American Academy of Arts and Sciences, Humanities Indicators, <http://HumanitiesIndicators.org>.

Figure 3

The Indicators can also call attention to under-noticed trends that bear further examination. For example, we have assembled data on teacher qualifications at the secondary-school level (see Figure 2). We saw that the qualifications of English teachers were slightly worse than those of science teachers, and only slightly better than those of math teachers. The qualification level of history teachers was significantly lower than that in any of the other fields. A good deal of attention has been paid to the shortage of qualified science and math teachers, but almost none has been paid to the comparable or worse shortages in secondary-school teachers of English and history. We also have data on the percentage of high school teachers in a number of fields, including science,

math, English, and history, that majored in the subject they are now teaching. Between 1988 and 2004, the proportion of people who majored in the subject they are teaching rose (see Figure 3). Surprisingly, the number has declined again since 2004, so we should be thinking about what that indicates.

These are just a few examples of how the Indicators afford us the ability to examine things to which little public attention has been paid. In this and many other ways, they can inform our discussion about the current health of the humanities. I invite you to explore them more fully and to begin drawing your own conclusions and starting your own conversations.

The Lincoln Project: Excellence and Access in Public Higher Education



Robert J. Birgeneau

Robert J. Birgeneau, a Fellow of the American Academy since 1987, is Chancellor Emeritus and Silverman Distinguished Professor of Physics, Materials Science, and Engineering and Public Policy at the University of California, Berkeley. He is Cochair of the Academy's Lincoln Project.

We launched the Lincoln Project in October of 2013. For our first year, we were largely in data-collection mode, trying to understand what the issues are and collecting quantitative information, some of it analogous to the Humanities Indicators data, which has been a valuable guide for us. Our practice of collecting and interpreting data will go on continuously, but we are about to shift our strategic emphasis somewhat, with the aim of not just producing Academy publications but also pursuing a political advocacy strategy. The 2016 election will therefore be guiding our schedule from this point forward.

Our project is named for President Abraham Lincoln, to commemorate his role in signing the Morrill Act of 1862, which laid the groundwork for the United States' unparalleled public university system. It is

clear that U.S. universities – especially public research universities – are increasingly challenged, and we formed this Committee to address that problem. The Academy is the ideal venue for the project because of the extraordinary breadth of the membership, of which we have taken full advantage.

America's educated and skilled workforce is highly dependent on the health of our public universities.

The Lincoln Project is cochaired by Mary Sue Coleman, former President of the University of Michigan; and me, Chancellor Emeritus of the University of California, Berkeley. Our respective institutions are unfortunately model representatives of the dire situation of state disinvestment in higher education. Our Committee members were deliberately selected from a very broad array of backgrounds. We have enlisted university leaders, both current and past, from both public and private universities across the country. We have a significant number of business people as well as representatives of learned societies. Also on the Committee are several former politicians, including Kay Bailey Hutchison, former U.S. Senator; Gray Davis, former Governor of California; Phil Bredesen, former Governor of Tennessee; and Jim Leach, former Iowa Congressman. Finally, and very importantly, we have engaged experts in quantitative research and analysis as well as communications in order to help combat the extraordinarily high level of misinformation about higher education. To make our case to the public, we need to have believable and objective data and an effective communication strategy.

The first question that one might ask is how American universities are doing. One way of addressing this is to look at international rankings of research universities. My personal favorite among those is carried out

by Shanghai Jiao Tong University, which ranks institutions on their excellence in the social sciences, science, and engineering. Their ranking methodology is data-based: its metrics include journal publications, citations per faculty member, and distinguished academic honors won by former

students and current faculty members. You can agree or disagree with the Shanghai Jiao Tong methodology, but at least its metrics are quantitative, transparent, and understandable.

If we look at the most recent Shanghai Jiao Tong ranking, which came out in September 2014, quite a few American flags are visible in their top-25 list. Manifestly, American research universities, both public and private, continue to do extraordinarily well, which leads some to ask, "Is there really a problem?" I do not have to tell any of my friends working in private universities that their institutions now seem much more fragile than they once did, especially after the 2008 recession. But for public research universities, the situation is far direr. Across the United States, on average, funding per student has declined dramatically in those institutions and tuition has risen correspondingly. The decline in funding per student shows no sign of slowing down. Recently, I was at one of our great state universities giving a physics colloquium. I met with the university president, who informed me that their administration is now including in its budget projections one scenario in which state funding goes to zero! Is a public university still public if the state funding is zero?

Clearly, we have a very serious challenge on our hands. I am often quoted as saying that we have many great universities in the

United States, both public and private, but we must have both. The Bay Area already has Stanford. We do not need a second Stanford in the form of a privatized Berkeley – we need a public Berkeley. Both institutions are important, but they play very different roles societally.

Berkeley has turned out to be an extreme example. In the 2002 – 2003 academic year, just before I began my tenure as Chancellor of the University, state funding represented just over one-third of our budget (34 percent; see the dark blue bar in Figure 4). During my time as Chancellor of UC Berkeley, state funding descended to a low of 10.5 percent of our total budget. Superficially, it appears that the situation has improved somewhat, because state funding has since risen to 13 percent. However, this is only because other funding sources, measured in real dollars, have dropped, not because state funding has gone up significantly. For example, student fees have been frozen for several years. All of the other funding sources – research, philanthropy, and student fees – now dwarf state funding (Figure 4).

Now let us look at the distribution of the elite public and private universities across the country (Figures 5 and 6). When Henry Brady, Director of the Goldman School of Public Policy at UC Berkeley, first showed me these data, I was astounded. There are only four states in the United States that have two or more elite private universities; another fourteen have one elite private university. In many cases, those private universities educate quite a small number of undergraduate students relative to the flagship public universities in the same states. The data show that the majority of states in the United States are without significant private research universities. Indeed, some highly educated states, such as Washington, Michigan, and Colorado, are left out completely.

The flagship public research universities (members of the Association of American

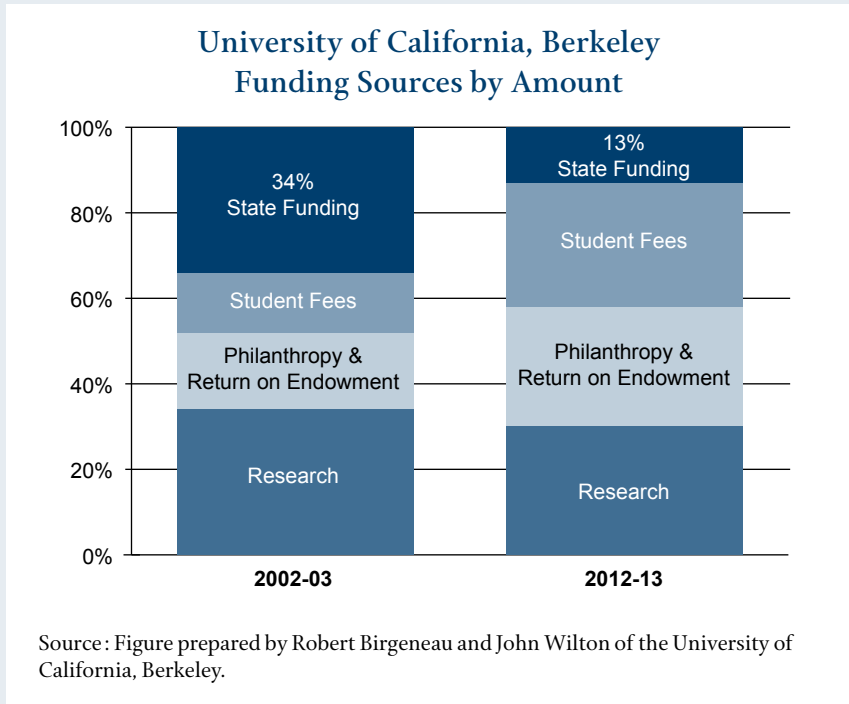


Figure 4

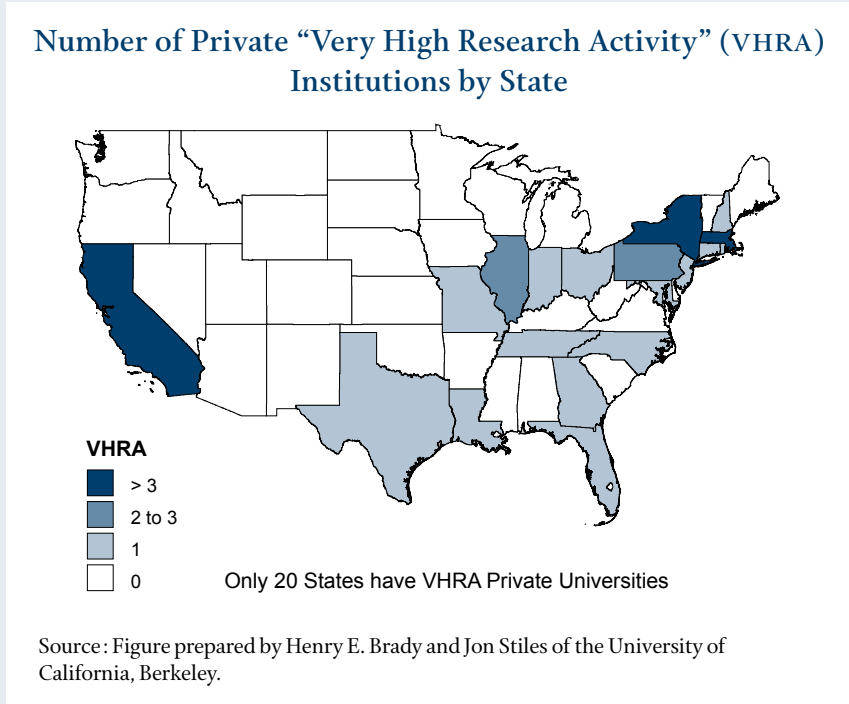


Figure 5

Universities, or AAU), on the other hand, educate a large fraction of the most talented university-attending population in the vast majority of the country.

If we include not just the AAU-level institutions, but also high-research-activity universities, of which many are private, the number of states with high-level private research universities goes up a bit. Even with these added, however, the vast majority of states have no private research universities, either of AAU caliber or of the next level down. If we look at the public universities of the same caliber, however, then we can see that every state in the country has a significant public research university. So, clearly, maintaining the health of these institutions is of paramount importance.

Another salient fact is that low- and low-middle-income students constitute 44 percent of the student body in public research universities, compared with 29 percent in private universities. Public universities act as the conduit into mainstream society for underprivileged but extremely talented people who will form the backbone of this country going forward. This is particularly true for underrepresented minorities: Latinos, African Americans, and Native Americans are overwhelmingly being educated in our public universities. From the absolute numbers for undergraduates, we see that the elite private universities have about five hundred thousand undergraduates, while the flagship public universities have close to three million. Clearly, America's educated and skilled workforce is highly dependent on the health of our public universities.

These are just some of the conclusions we have reached so far in the Lincoln Project. The data make evident that maintaining our public research university system is of the utmost importance. In addition to spreading awareness, we also wish to address a number of important issues going forward.

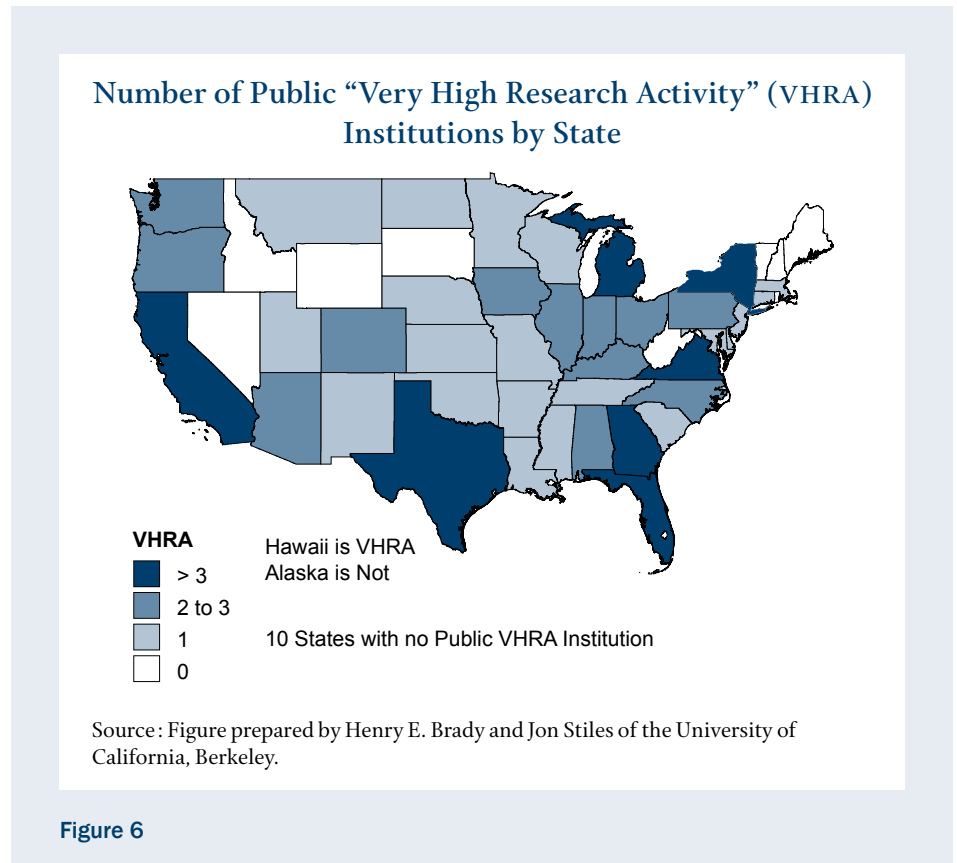


Figure 6

First, one might ask who is missing entirely in the public research university funding picture? We are the only country among our economic competitors where the federal government does not contribute directly to the operations of our great public research universities. In every single other country with whom we compete, the federal government understands that the health of the public research university system is critical to the country's future as a whole. Washington needs to step up!

My second point – and perhaps a more controversial one – is that industry is by and large not making its fair contributions to education through the tax system. Corporations across America continuously hire graduates from our leading public universities while having contributed minimally

to the cost of their education. This has to change. There are many ways that this could happen. I would like to conclude with a proposal that is specific to California but could be easily generalized to other states. If high-tech corporations in California were simply to repatriate annually 1 percent of their revenues which they are holding off-shore and donate those to the University of California and the Cal State universities, this would solve permanently the financial problem for public higher education in the state of California. My one extended conversation with a Congressman deeply committed to education indicates that this is by no means an irrational suggestion.

The Lincoln Project: Excellence and Access in Public Higher Education



David B. Frohnmayer

David B. Frohnmayer, a Fellow of the American Academy since 2002, is President Emeritus of the University of Oregon. He joined Harrang Long Gary Rudnick P.C. as “of counsel” in 2009. Previously he served as Oregon Attorney General, in the Oregon House of Representatives, as legal adviser to the University of Oregon president, and as Dean of the University of Oregon School of Law. He serves as a member of the Academy’s Board of Directors and as an advisor on the Academy’s Lincoln Project.

Public research universities are extraordinarily important institutions: they have provided great opportunities for the United States, and for individuals in this room who credit public higher education with their chance to live the American Dream. However, as Robert Birgeneau just shared with you, these institutions are currently dangerously fragile.

The Lincoln Project comes from the same wellspring of the Academy’s engagement as the other great efforts of which you heard this morning. I mentioned that these institutions are important. It should also be understood explicitly that they are

Notwithstanding public universities’ great impact, their storied origins, and the sheer quantity of students that they engage, their future success is precarious.

a national public good and that while they are state-directed, they serve national and, indeed, international purposes. Their noble historical tradition extends back to the first Morrill Act. They enroll millions of students and provide them with quality higher education. They are research engines in their own right. They are also vastly significant regional economic powerhouses – a largely overlooked fact that we hope to highlight in our work.

Notwithstanding public universities’ great impact, their storied origins, and the sheer quantity of students that they engage, their future success is precarious. There is no federal system of higher education. As Bob pointed out, quite shockingly, we are the only nation in the developed world that does not have a national policy in place to support public higher-education institutions. Competing demands on state budgets have been devastating. Medicaid, prison expansion, and voter-driven tax reductions are just a few policy priorities that, at least in my state of Oregon, have powerful political constituencies. In some cases, the withdrawal of state budget support due to the whole of these competing interests has been close to catastrophic. This gives currency to a shopworn adage – at least among public-university presidents – that public universities have gone from being state-supported to state-assisted, then state-located, and finally state-molested.

Many of these institutions do not have the same tradition of private philanthropy as private institutions, and they certainly do not enjoy the same wealthy endowments. So the pressures of the current moment are

even more demanding on them. Maintaining accessibility means that they do not, politically or even ethically, have the same capacity to raise tuition levels. This creates enormous dilemmas; in both public and private institutions these days, an enormous amount of the subsidy of basic research actually comes on the backs of undergraduates, from the tuitions that they and their families pay.

Significant data have been collected, and the Lincoln Project will use this information to make a data- and evidence-based case for the public university to a degree that is unusual for recent years. We want to enlist the support of any Academy Fellows who wish to work with us on this project, because our conclusions are still being formulated. Even at this early stage, however, we foresee seven or eight points that will be part of the Academy’s report on this project.

First, we will be doing a lot of demystification. There is an enormous amount of misinformation and overgeneralization about the levels and degree of student debt: where it is, how much there is, and how much of that is offset by financial or scholarship assistance. I think that deconstructing myths about debt – and some of the other stereotypes about higher education that command our current political template – is extraordinarily important.

Second, it is critical that we find strategies to enlist business and industry. We need private-sector leaders – not merely the shareholders of their corporations – to be our champions. Third, we have discussed potential contours of a twenty-first-century approximation of the Morrill Act of 1862, which established public land-grant univer-

sities. Fourth, we will build on the *Restoring the Foundation* report, continuing its project of encouraging research much more comprehensively.

Fifth, we will explore incentives to philanthropy, whether through the Internal Revenue Code or other mechanisms. Sixth, we will call for the reinvigoration of the state's active role in maintaining the public research university as an essential piece of the American Dream. Seventh, we will underscore changing student demographics, because they will have a significant impact in the long run. In many states, the college-age population is either falling or predicted to fall; the ethnicity and preparatory educational backgrounds of students also continue to shift. While demographics may not be destiny, demography is certainly a powerful tool for anticipating the educational needs of the next generation of students in the higher-education opportunity. Finally, but not exclusively, we hope to uncover and highlight best practices that might be transferrable from one institution or region to another.

We hope that our pursuit of these essential and challenging questions will make this a project worthy of the Academy's efforts and of the efforts of so many others in the past who have committed themselves to ensuring the accessibility and excellence of public education. ■

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Dædalus Asks, “What is the Brain Good For?”

What is consciousness? How do we store memories, process thoughts, and command our bodies? Why do we require sleep to live? And can we trust our perception of the world around us?

The Winter 2015 issue of *Dædalus* responds to these fundamental questions of human experience, exploring “What is the Brain Good For?” through recent developments and new theories in the field of neuroscience. Guest edited by Academy Fellow Fred H. Gage, the Vi and John Adler Professor in the Laboratory of Genetics at the Salk Institute for Biological Studies, the collection of essays investigates the neural networks and processes that support a variety of brain activity, spanning unconscious sensory experience to higher cognition.

The ten essays in this volume each explore a different region within the field of neuroscience, but they also share a focus on neurons, the fundamental unit of the nervous system. How neurons form circuits, networks, and anatomical structures define our experiences, from our senses (hearing, seeing, touching, tasting, and smelling) to our emotions and complex decisions. As Gage explains in his introduction, “We now know that the human brain contains approximately one hundred billion neurons and that these neurons have some one hundred trillion connections, forming functional and definable circuits.” Fortunately, Gage continues, to guide us through this dense wilderness are authors who not only have made significant contributions to their field, but who are also “experienced communicators with track records of explaining and translating complex concepts to intelligent readers and listeners outside of their discipline.” “What is the Brain Good For?” presents the opportunity for the lay reader to engage with the profound and rapidly shifting questions of neuroscience.

Among the essays in the volume, Thomas D. Albright’s (Salk Institute for Biological Studies) essay, “Perceiving,” explores the critical process of perception, “by which evanescent sensations are linked to environmental cause and made enduring and coherent through the assignment of meaning, utility, and value.” A. J. Hudspeth (Rockefeller University) examines one of the key inputs of perception in “The Energetic Ear.” Here Hudspeth explains that the ear is not simply a passive receiver of sound, but an amplifier that “augments, filters, and compresses its inputs” before they are interpreted in the brain. Amazingly, the ear’s two motile processes are so active that our ears can actually *emit* sound.

Earl K. Miller (Massachusetts Institute of Technology) and Timothy J. Buschman (Princeton University) focus on the mechanisms behind cognitive capacity: the explanation for why “we can store (seemingly) a lifetime of experiences as memory, but can only consciously express these thoughts a few at a time.” And finally, Terrence J. Sejnowski (Salk Institute for Biological Studies) takes

on the thorny topic of consciousness. What brain mechanisms underlie consciousness? And what is consciousness to begin with?

Print and Kindle copies of the new issue can be ordered at: <https://www.amacad.org/publications/daedalus>. ■

Winter 2015 *Dædalus* “What is the Brain Good For?”

Fred H. Gage (The Salk Institute for Biological Studies), *Neuroscience: The Study of the Nervous System & Its Functions*

Robert H. Wurtz (The National Eye Institute), *Brain Mechanisms for Active Vision*

Thomas D. Albright (The Salk Institute for Biological Studies), *Perceiving*

A. J. Hudspeth (Rockefeller University), *The Energetic Ear*

Larry R. Squire (Veterans Affairs San Diego Healthcare System; University of California, San Diego) and John T. Wixted (University of California, San Diego), *Remembering*

Brendon O. Watson (Cornell University; New York University School of Medicine) and György Buzsáki (New York University School of Medicine), *Sleep, Memory & Brain Rhythms*

Emilio Bizzi (Massachusetts Institute of Technology) and Robert Ajemian (Massachusetts Institute of Technology), *A Hard Scientific Quest: Understanding Voluntary Movements*

Joseph E. Ledoux (New York University), *Feelings: What Are They & How Does the Brain Make Them?*

Earl K. Miller (Massachusetts Institute of Technology) and Timothy J. Buschman (Princeton University), *Working Memory Capacity: Limits on the Bandwidth of Cognition*

Terrence J. Sejnowski (The Salk Institute for Biological Studies; University of California, San Diego), *Consciousness*

Advancing Knowledge: Selections from the Archives of the American Academy

A new publication from the Academy, released in January 2015, features selected materials from the Academy's Archives. Published to celebrate the 235th anniversary of the institution's founding in 1780, *Advancing Knowledge* reflects the rich intellectual history of the Academy and the nation.

The volume, which combines color images with transcriptions and historical vignettes, showcases letters of acceptance written by Academy members George Washington, Alexander Hamilton, Charles Darwin, Albert Einstein, Willa Cather, Robert Frost, and Mary Leakey, among others; communications submitted to the Academy on topics ranging from human flight to rare medical cases; and historical documents that illustrate the inner workings of the organization in its early years.

As Bernard Bailyn notes in his introduction to the publication:

One does not usually think of documents dug up from an academy's archives as likely to be particularly interesting, but these records, selected by the Academy's Archives staff from among the papers of the Academy's early years, have a remarkable fascination. Even on the surface they reflect the members' intellectual personalities and styles, and repeatedly they touch on vital passages in the nation's emergence into modernity.

Copies of *Advancing Knowledge* were distributed to all Academy members, to the Academy's University Affiliates, and to select libraries, historical organizations, and learned societies. ■

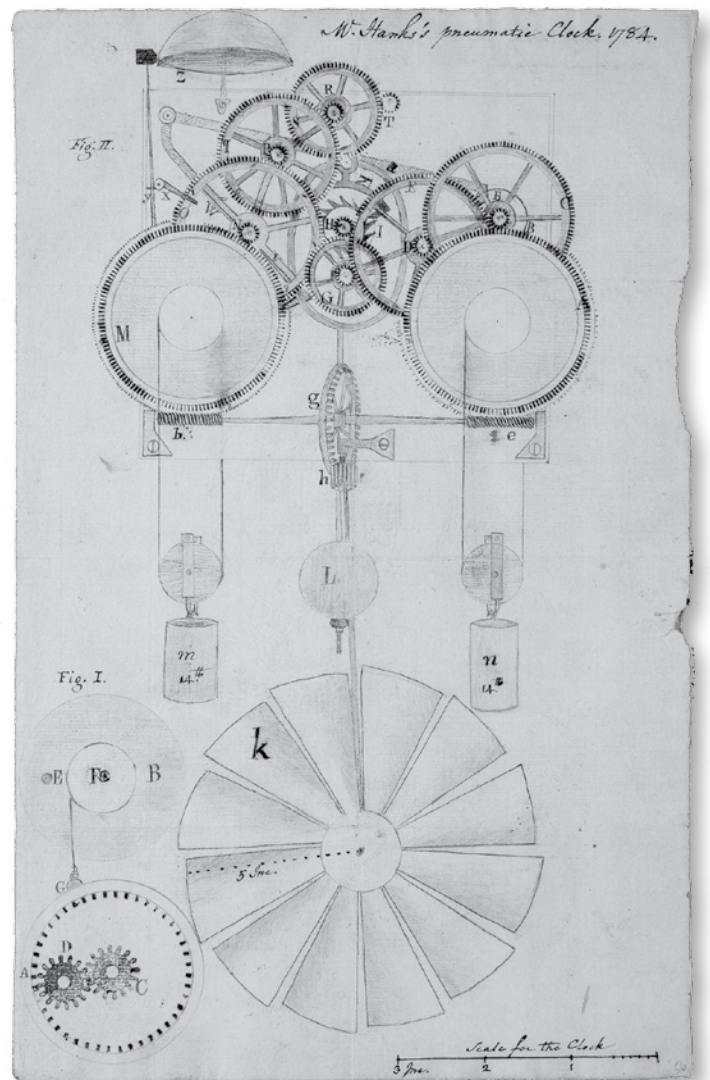


Illustration for a pneumatic clock by Benjamin Hanks, July 1, 1784 (*Advancing Knowledge*, p. 70)

Russia—At the Crossroads Again?

On November 12, 2014, at the Academy's 2012th Stated Meeting, Valerie Bunce (Aaron Binenkorb Professor of International Studies and Professor of Government at Cornell University), George W. Breslauer (Professor of the Graduate School and Executive Vice Chancellor and Provost Emeritus at the University of California, Berkeley), and Timothy J. Colton (Morris and Anna Feldberg Professor of Government and Russian Studies and Chair of the Department of Government at Harvard University) discussed the ongoing crisis in Ukraine and Russia. The following is an edited transcript of their presentation. A group of Fellows and guests gathered in New York City to watch the live stream of these presentations. Stephen Holmes (Walker E. Meyer Professor of Law and Faculty Co-director of the Center on Law and Security at New York University School of Law) led a discussion following the video presentations. This was the first time the Academy merged remote presentations with in-person discussions.



Valerie Bunce

Valerie Bunce is the Aaron Binenkorb Professor of International Studies and Professor of Government at Cornell University. She was elected a Fellow of the American Academy in 2010.

Due to current events, we will all speak this evening in some fashion about the ongoing crisis in Ukraine. I will present four observations on the situation. The first is that the crisis in Ukraine is in my view best understood as an interstate war, not an intrastate war. I am implying here that Russia has committed aggression against Ukraine in two ways: by invading and

A critical and largely overlooked factor in Putin's decision-making was his fear that the protests in Ukraine could inspire similar dissent in Russia and thereby challenge his power and destabilize his regime.

annexing Crimea in February and March of this year, and by aiding and abetting popular unrest in Eastern Ukraine. My second point is in reaction to many of the analyses of Russia's motivations for taking such actions: most of them have focused on international influences, but domestic influences are extremely important as well. I think a critical and largely overlooked factor in Putin's decision-making was his fear that the Euromaidan protests in Ukraine could inspire similar dissent in Russia and thereby challenge his power and destabilize his regime.

Putin had good reasons to be fearful of the possibility of the diffusion of popular unrest from Ukraine to Russia. The issues driving the protests that began last November in Ukraine—corruption, the abysmal state of the Ukrainian economy, and the authoritarian rule of then-president Viktor Yanukovich—could easily resonate with Russian publics, especially since Russians identify closely with Ukrainians. Indeed, Russia had experienced its own significant protests in 2011 in connection to many of the

same issues raised in the Euromaidan protests. Finally, and most significantly, Putin had watched one post-communist authoritarian ruler after another lose power in the Color Revolutions, which began in Eastern and Central Europe in the second half of the 1990s (in Slovakia, Croatia, and Serbia) and then moved to the post-Soviet space (Georgia, Ukraine, and Kyrgyzstan). In these election-based revolutions, an unprecedented coalition between opposition parties and civil society groups surprised the regime, most citizens, and even itself by defeating authoritarian incumbents or their anointed successors and thereafter taking national office. Opposition groups were able to win despite the regime's reliance (as usual) on electoral fraud, because they deployed sophisticated campaign techniques that increased voter turnout, convinced voters that the opposition could and should win, and exposed electoral fraud. In many cases, moreover, the opposition orchestrated large-scale popular protests when the regime refused to abide by the results of the

election. The Ukrainian Color Revolution in 2004 was particularly upsetting to Putin, because of the close ties between the two countries and the fact that his regime had bankrolled the candidate who, in the face of popular protests, was finally forced to admit defeat. This admission, moreover, came after Putin had congratulated his candidate on his victory – even before the original votes had been counted! Thus, for Putin, the Color Revolutions were threatening in a number of ways. They demonstrated that authoritarian rulers in neighboring countries could be quickly toppled, and that these processes of political change could travel quickly across state borders. Because these regimes were similar to Russia, moreover, it was easy for Putin to assume that Russia would be the next target.

By coding the Ukrainian protestors as fascists, Putin was able to claim that Russia was merely embracing certain international norms, such as the responsibility to protect and the right of nations to self-determination.

This leads to my third point about the crisis in Ukraine. On the face of it, Putin's actions in Ukraine seem puzzling, if not very risky. For example, why seize Crimea, violating international law and inviting Western reprisals, and why destabilize Eastern Ukraine and thereby expose Russia to more instability on its borders? A closer look at Russian actions, however, suggests that Putin's repertoire of intervention in Ukraine was carefully designed to accomplish several objectives simultaneously. For one, Russian actions in Ukraine played to Russian nationalism and boosted Putin's popularity – by demonstrating Russian power in the international system, by

returning Crimea to Russia (its “historical” home), and by winning back extreme nationalists that had been dissatisfied with Putin's politics. For another, because of the purported threats posed by the “dangerous” developments in Ukraine, Putin provided a rationale for introducing more repressive measures at home. The intervention was also designed to limit the West's capacity to respond forcefully to Putin's aggression by denying Russian involvement in Eastern Ukraine, by reminding Europe of its energy dependence, and by appealing to international norms. Finally, Putin aimed to destabilize Ukraine, making it easier for Russia to exert continued influence there while simultaneously making it more difficult for Ukraine to argue credibly for its entry into the European Union and NATO.

Let me provide one example of Putin's “toolkit of intervention.” By portraying the Ukrainian protestors on the Maidan as fascists and, by extension, as threats to Russian security, Putin tapped into various historical tropes in both Russia and Ukraine and, in the process, rallied Russians around the flag. This allowed him to build a stronger case for annexing Crimea, to speak and act on behalf of the purportedly endangered Russian minority in Eastern Ukraine, and to expand his control over the Russian media. In addition, by coding the protestors as fascists, Putin was able to claim that Russia was merely embracing certain international norms, such as the responsibility to protect

and the right of nations to self-determination. He also emphasized the international standard of respect for the will of the voters when the deeply flawed referendum held in Crimea led to widespread popular support for joining Russia.

Putin's game of invoking certain norms essentially diverted attention away from his violation of the international norm of state sovereignty – a norm that is widely understood as the foundation of international peace. This manipulation of international norms made it harder for the West to coalesce around a strong response to Russian aggression, and it guaranteed Russia a role in the peace process. This meant, in effect, that Russia would serve as a coarchitect of the new Ukrainian state and regime; it also held open the possibility that Putin would be able to create a statelet in Eastern Ukraine, which would weaken the Ukrainian state as a result of its loss of territorial control, while at the same time preserving Russia's influence in Eastern Ukraine.

Finally, it is clear that there have been short-term benefits to Putin's strategy in Ukraine, but the long-term picture of his accomplishment is much more problematic. First, NATO has in response moved to redefine its mission and expand its capabilities. How far it will go in that endeavor remains to be seen. Second, other important allies that border Russia and have significant Russian minorities, such as Kazakhstan, are now distancing themselves from Russia, worrying that they could be the next Ukraine. Third, the economic burdens of Crimea, coupled with the costs of the economic sanctions of the West, a huge increase in the Russian defense budget, and a sharp decline in global energy prices, mean that the Russian economy is in serious trouble. Strong economic performance, it is important to note, has served as the foundation for Putin's power since 2000. Fourth, Europe is rethinking its energy dependence on Russia and focusing

attention on (among other things) making greater use of alternative pipelines, which is technically possible right now.

Finally and most important, Russian actions have allowed Ukraine to accomplish something it had not been able to accomplish in twenty-three years of independence. In the recent parliamentary elections, both Russia-friendly and right-wing extremist parties did very badly and a consensus emerged supporting democratic change, an end to corruption, economic reforms, and integration with Europe. So ironically, because of Russian aggression, Ukraine is better positioned today than ever before to move out of Russia's zone of influence and to fully embrace Europe.



George W. Breslauer

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I have never been a part of the chorus that is quick to blame the United States when something goes wrong internationally. But in the case of Russia, I think we brought the current problems upon ourselves.

There are two basic perspectives in the public media on how the situation in Russia and Ukraine came about. The first, which Professor Bunce has argued quite brilliantly in her recent work, situates Putin as the prime mover. A number of characterizations of Putin account for this position: either he is a neoimperialist who finally felt strong enough to impose his will on Ukraine, a thug by inclination, an authoritarian leader seeking to avoid political loss; or he wants the political-economic regime in Ukraine to resemble that of Russia. A second perspective in the Western media is more international and views Putin in this case as not a particularly likeable or benev-

olent fellow, but nevertheless as a leader responding to an intolerable international provocation: namely, U.S.-led efforts to guide Ukraine into the European Union and ultimately into NATO. One could dodge the issue and say that it is something of both, but one then falls into the trap of overdetermination, where it is impossible to say which factor is decisive.

I believe that the international factor was decisive. That is not to say that I necessarily buy into all of the secondary arguments made by advocates of this view. For example, before Russia stoked nationalism and revanchism in Eastern Ukraine, relations between Ukrainians and Russians in that region were not especially problematic. I neither idealize nor demonize either side; there are no saints in the conflict, but it was avoidable. At root, this is about the history of NATO's expansion eastward, accompanied by U.S. insistence on installation of a missile defense system in Eastern Europe as well as actions in Southern Europe (Serbia, Kosovo), Northern Africa (Libya), and the Middle East (Iraq, Iran, and Syria). This pattern of behavior was perceived in Moscow, perhaps not all that inaccurately, as consistent with the notion that the United States views itself as the actor dictating the terms of the post-Cold War international order. Putin has said as much in his public comments; his foreign minister, Sergei Lavrov, said as much at the United Nations recently. If you read what they had to say, I would challenge you to ask yourself, "Is that really so incredible? Is it so difficult to believe that the Russians actually believe what they are saying?" In light of what has happened over the last twenty-five years, my response is no, it is not difficult to imagine.

To understand why Ukraine is so sensitive to Moscow, look at the nature of the Russian Empire and the Soviet Union. These were contiguous, not overseas empires. This meant that managing the

loss of empire was not only a matter of neo-imperial nostalgia (of which there has been a great deal in Russia, predating this crisis), but it would also be defined as a national security issue precisely because of the geographic proximity or contiguity of Russia to the former satellite states. Recall that “Ukraine” means “borderland” in Russian. Boris Yeltsin, who, in the 1990s, was trying to integrate Russia into the West, nonetheless referred to the former Soviet republics as the “near-abroad.” (This is perhaps analogous to the folksy American habit of referring to Central and South America as “our backyard.”)

Although both Gorbachev and Yeltsin wished to integrate Russia into the U.S.-led international order, dismay and disillusionment set in when they realized that the United States was more inclined to treat Russia as either a vassal or a rival.

Another point I would like to make is that NATO expansion has had a dual effect of emboldening target governments and angering Moscow at the same time, which is a potentially incendiary combination. For example, in 2008, when Georgian president Mikheil Saakashvili was deploying troops against the breakaway republics of South Ossetia and Abkhazia, he spoke with Putin on the telephone and warned him that the West would punish him if he resisted. Putin’s response was essentially to tell the Georgian president where he could stuff the West.

This anger in Moscow is not a sudden phenomenon; it has developed gradually over time. In the 1990s, Russia almost simultaneously lost its empire, its status as a global and regional power, and its leadership of the so-called World Communist

Movement – all of which was hugely disorienting. Both Gorbachev and Yeltsin, in their disorientation, proceeded on the premise that they had to convince the United States to help them engineer a soft landing from this free-fall: integration into the U.S.-led international order. Dismay and disillusionment set in when they realized that the United States was more inclined to treat Russia as either a vassal or a rival. Putin came to power in the year 2000, and subsequent trends turned disillusionment into anger, and more recently, anger into indignation.

Ironically, Putin was not initially predisposed to succumb to worst-case thinking

about the United States’ intentions. Rather, he had a very strong pragmatic streak in his approach to international relations; recall that he was the first foreign leader to call President Bush after 9/11, and he initially sought a U.S.-Russian alliance against Islamic terrorism. He (as well as Yeltsin) had even publicly hinted at the idea of Russia joining NATO. Dmitry Medvedev, in 2008, called for a new East-West security policy after the Georgian War. Russia helped the United States in Afghanistan and in Syria and currently may be assisting in negotiations with Iran. The United States uses Russia when necessary, but otherwise ignores their pleas. As Andrei Tsygankov of San Francisco State University revealed, the Russian foreign minister said in June 2006 – two years before the war with Georgia – that Ukraine or Georgia joining NATO

would constitute a “colossal” shift in global geopolitics. We ignored that, but it seems prudent to pay attention when a foreign minister publicly uses the word “colossal.”

Another point is that the United States and Russia appear to have the ironic misfortune of being out of phase in their foreign policy cycles. The Soviet Union envisioned itself a global missionary. That self-conception was jettisoned by Gorbachev, Yeltsin, and later Putin. Putin sought collaboration with the United States on militant Islamic fundamentalism, which he thought was the main enemy, and did not embrace a “global missionary” ideology. But just then, the “global missionary” strain in U.S. foreign policy came back to the fore with a vengeance under George W. Bush. That is, just as the Russians were transitioning from a “missionary” foreign policy to a more pragmatic one, we were swinging from pragmatic to missionary, and that complicated the relationship enormously.

What was the turning point in Ukraine? I place it at February 21, 2014. Before that date, nothing had been predetermined in terms of how this would turn out. A deal had been struck among representatives of the European Union, Russia, and the Ukrainian government to slow down this revolution and make for a more gradual transition. The protestors in Maidan Square did not accept the deal. They stormed the parliament and chased out the president, but the United States then embraced this new reality rather than bemoan it, despite the fact that this deal had been struck just a day earlier. Our reaction led Moscow to again assume the worst about our intentions.

Further, escalation can create dynamics of its own, regardless of original intentions. After taking Crimea, Putin found himself in need of a retroactive justification for the act, which he found in romantic nationalism. Previously, the type of nationalism that Putin had espoused publicly was primarily

After taking Crimea, Putin found himself in need of a retroactive justification for the act, which he found in romantic nationalism.

oriented toward national security and pride: he emphasized having pride in one's country and pride in one's status. Then, with the seizure of Crimea, Putin's brand of nationalism changed considerably. He embraced the notion of *Novorossiya*, or "New Russia," the name given by Russian nationalists to an imagined empire of Russian-speaking and Russian-identified regions, including Crimea and the Donbass region of Eastern Ukraine. He reminded Russians that Ukraine's relationship with Russia goes back one thousand years to when Kiev was the seat of Kievan Rus'. Putin also upped the rhetorical ante by greatly emphasizing the ethnic descriptor *Russkiy* at the expense of the more civic and non-ethnic *Rossiyskiy*.

When the Ukrainian government was first planning to send troops into Eastern Ukraine to crush the insurgency stoked by the Russians, Russian foreign minister Sergey Lavrov called it "a colossal mistake." Once again, politicians and diplomats typically do not use such strong language in public, and we should have realized this meant that the Russians were not going to let the insurgency in the East lose. It did not mean that they were going to try to crush or occupy all of Ukraine, but they were going to do whatever was necessary to prevent loss. Through this we gain the deeper insight that a state's behavior during a spiral of escalation is not necessarily indicative of its original intentions. Ambitions may escalate as well during the spiral. To solve this foreign-relations problem, I believe it will be necessary to reframe the rhetoric on both sides, because as things currently stand, any deal that *is* struck may be difficult to sell both in Washington and in Moscow. We

must reframe the rhetoric so that if a compromise is made, it does not appear that we are abandoning Ukraine; nor will it appear to Russians that *their* leaders have abandoned Ukraine to a government populated by what Moscow is calling "fascists."

I want to end with a pair of strong counterfactual claims that cannot be proven, but are logically consistent with the argument that I have been making; claims that I therefore think have the virtue of highlighting your assumptions. First, had there been no U.S.-led effort to prepare Ukraine for NATO membership, had we listened to France and Germany's advice against it, had there also therefore been no U.S. involvement in the Maidan protest (however secondary it was, it was nonetheless associative), I believe that Crimea would still be part of Ukraine and there would be no military insurgency in the East. My second counterfactual claim is that, were Putin not the President of Russia but had U.S. policies remained the same, Russian military intervention in Ukraine would have happened anyway.



Timothy J. Colton

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In my remarks tonight I wish to discuss nationalism, or perhaps more appropriately, nationalisms. Nationalism is a slippery thing. It is about identity, about who you are and who you think you are. Scholars nowadays are inclined to say that at its core are "imagined communities": it is contingent; it is not biologically determined or primordial. Consider the 1990s, when the Wall had just fallen, the Soviet Union had disintegrated, and communism was being superseded by something new. Some of the very best analysts, Valerie Bunce among them, observed that at such a time, one should not really expect politics to revolve around considerations of interest. Why? In communist societies, natural processes that form socioeconomic interests (processes that we take for granted in our society) are largely absent, or are at least very weak. For example, there was

The concept of spheres of influence is very dear to Putin's heart: this theory suggests that Russia should be surrounded by a buffer zone of regions under its control.

no right to private property, or at least to productive private property, and income distribution was egalitarian. For these and other reasons, analysts claimed twenty or twenty-five years ago that interest politics may come along eventually, but not just yet. It would take a while for these former Soviet countries to develop the advanced market economies and modern societal structures that would support interest-based politics. In the meantime, these analysts predicted, identity politics would dominate the conversation.

This model fits the experience of many countries in East Central Europe fairly well. In Russia, however, what we have seen in the last ten years or so is a curious inversion of the expected sequence. When Putin first came to power in 2000, he was very much an interest politician. He dwelt on the fact that Russia had fallen behind its peers, that it must catch up with the rest in order to survive.

The so-called Millennium Manifesto is a long essay written and published online in Putin's name in December 1999, just before he became president. That document contains very little in the way of identity politics. In fact, in it, Putin explicitly claims that Russia does not need a national idea. "Let's not worry about that," he suggests, "Let's try and catch up and become more like the others, while still preserving the things about ourselves that we value." He did not propose that Russia become exactly like Germany or France, but he did suggest a move in that direction. One could argue that the politics of his first two terms in office, from 2000 to 2008, were largely about interest. Putin also had the good fortune to be

leader of the country when it was experiencing a remarkable economic boom. I think that boom, which made the state stronger, which gave it money to spend and money to reward people with, was largely responsible for the very high levels of authority and popularity that he enjoyed, as well as the interest-based politics that he pursued. Now, this is not to say Putin ignored identity issues completely, but they certainly did not consume him. If we look at the politics of the last six months or so, however, and at the propaganda and information wars that have taken place on television and in other media, we see a very different Putin.

This leads me to my discussion about nationalisms. For reasons that I do not fully understand – that I do not think any of us fully understand – nationalism has become more relevant to the politics of Russia in the last eight years or so. To some extent, this was surely a conscious choice on the part of the people who lead the country, but I think there is more to the story than that. Because of Russia's history and the unique way the country has developed, this story is probably more complicated than anything we would come up with for American or French nationalism. To get at this story, and to begin to parse out the various threads of nationalism we see in Russia, I would like to pose two questions.

The first question is whether we are talking about civic nationalism or ethnic nationalism. This is a distinction that one has to make in Russia, because there is a majority ethnic group called the ethnic Russians, or *Russkie*; and then there is the country, which is 80 percent Russian, but

20 percent minority. Twenty percent of 150 million is a considerable population. That is the first question.

The second question is, exactly what geographic sphere or ambit are we talking about? *Which* Russia? Today's Russia or something larger? The geographic reference of standard-fare Russian nationalism is the small Russia: Russia's borders as they currently exist, perhaps now including Crimea. This brand of nationalism includes things that we probably associate with patriotism or national feeling in many countries, ranging from patriotic pride to anti-globalism and anti-Americanism. National unity, which was very important in Russia given its secessionist history in the 1990s, is involved here, as is "great-powerism" and the insistence that others not interfere in its internal affairs.

There is then a second school of nationalism that makes reference to some imagined "big Russia," whose boundaries extend beyond those of the current state. This can be defined in a variety of ways, including a civilizational approach, which looks far back in history to medieval times and usually makes some association with Russian Orthodoxy. The concept of spheres of influence, which is very dear to Putin's heart, is also at play here: this theory suggests that the small Russia should be surrounded by a buffer zone of regions under its control. The Russian Empire of the eighteenth, nineteenth, and early twentieth centuries; the Soviet Union; Eurasia, which is not quite the same as any of those previously existing categories; and pan-Slavism, which is probably the least relevant, are all other models of expansive Russian nationalism.

I will now return to the first question and the distinction between civic and ethnic Russianness – both of which find their place in Russia's various nationalisms. The first President of Russia was Boris Yeltsin, who served in the 1990s. His thoughts were mostly on

economic development; he wanted to keep the country together and was willing to use force to do so, so national unity was important. He wanted Russia to be a great power and took patriotic pride in his country. He was interested in spheres of influence, but did not obsess over them, because they were fairly easy to maintain in the 1990s. The West was not as present in the post-Soviet space, so strong anti-American and anti-globalist tendencies had not much taken hold. Yeltsin was also utterly unconcerned with ideas of ethnic Russian nationalism.

Putin is wedded to the idea of some kind of Eurasian unit that largely corresponds to the boundaries of the former Soviet Union, of which Russia would be the core; he wants this to develop as an alternative to the European Union.

Flash forward to Putin, and of course, things become more complicated. We see Putin not only embracing the full spectrum of small-Russia nationalism (as Yeltsin probably knew Putin would when he selected Putin as his successor), but also many aspects of big-Russia nationalism and at least a few aspects of the third idea of “ethnic-Russian” nationalism. Putin has shown himself willing to make foreign policy choices that privilege the big-Russia vision to some extent, and is often accused of being nostalgic for the USSR. That is probably not exactly right, but he is at least wedded to the idea of some kind of Eurasian unit that largely corresponds to the boundaries of the former Soviet Union, of which Russia would be the core; he wants this to develop as an alternative to the European Union. As far as ethnic Russians are concerned, the phrase *Russkiy mir* (“Russian world”) has now become a kind of slogan

for those rallying around the idea of ethnic Russianness. It is also the name of an organization started up by Putin that projects Russian soft power and cultural influence both in its immediate neighborhood and abroad. Irredentism has also arrived on the agenda, which has surprised most foreign observers. Now we wonder: will Crimea be the exception to the rule, or is its seizure just the first in a long string of irredentist actions?

To be fair to Putin, there are certainly also aspects of nationalism that do not interest him. I do not think he is willing to give up

too much for the fraternal Serbs in the Balkans, first of all. He is also not anti-minority, anti-migrant, or anti-Semitic; he does not have any apparent racial biases. Furthermore, he is rarely accused of harboring these feelings, even by his harshest critics. However, the nationalisms now espoused by both Putin and various other representatives of the Russian government pull the country in a number of different directions, and every now and then, Putin is willing to address this.

I want to note here that in the Russian language, the word *nationalist* is and always has been something of a bad word. *Patriot* is just fine; in the Soviet days, you could be a Soviet patriot; today, you can be an Estonian patriot or a Russian patriot, of course. But being an Estonian or a Russian nationalist in Soviet days was not tolerated, largely because there really was no Soviet *nation* to speak of.

Recently, at the annual Valdai Discussion Club, the Russian-American analyst Nikolai Zlobin said to Putin, “It looks to me like your patriotism is morphing into something more menacing, which I would call nationalism, and that you are using it to silence dissent.” Putin’s reply was quite complex and maybe a bit confused. He first acknowledges that patriotism can turn into nationalism and that this can be dangerous (which is probably his Soviet education speaking). Then, however, right in the middle of his answer, he adds, “the biggest nationalist in Russia is me.” Then he qualifies this statement somewhat by saying that nationalism is only appropriate when it benefits the people. Finally, in keeping with a tendency on his part to think of worst-case scenarios, he notes that if nationalism (which he has now admitted into the range of licit behaviors) comes to mingle with intolerance, it would destroy Russia. Why is this? It is because Russia is a multiethnic, a multilingual, multi-confessional state.

Clearly, he is flipping here from one meaning of nationalism to another, and he is not the only one. Putin is not really an original thinker when it comes to these categories. He largely mimics and absorbs the categories of others. There is an extensive discourse and debate about these things. Many of the theorists of Russian nationalism, whom I call nationalist entrepreneurs, have been on the scene since the 1990s. Vladimir Zhirinovskiy, for example, is a well-known Russian nationalist and populist. Dmitry Rogozin, who is now probably the third or fourth most powerful person in Russia, was the cofounder of a nationalist party in the mid-1990s. Vyacheslav Nikonov is a theorist of Russian soft power and president of the organization *Russkiy Mir*. Aleksandr Dugin is Russia’s best known Eurasianist intellectual. Aleksandr Belov is the founder of an organization called Movement Against Illegal Immigration; his anti-immigration

stance has very strong racial overtones. As you can see, nationalist thinkers are quite prominent, but there is a lot of diversity within that spectrum of views.

There is a mass aspect to Russia's nationalisms: there are showings of popular nationalist sentiment. Some are heavily staged and scripted, though others are more like spontaneous acts of protest. The annual *Russkiy Marsh*, or ethnic Russian March, has taken place every fourth of November since 2005. Part of its purpose is to celebrate Russia's virtues, but it is also very distinctly anti-immigrant. Since about 2008 or 2009, there has been a violent undercurrent in Russia with respect to ethnic issues. The best-known event, and the one that scared the leadership the most, was the so-called Manezh Pogrom of 2010. Following an incident in which a Russian soccer fan was stabbed to death in a fight with young men from the North Caucasus, a spontaneous flash mob of tens of thousands of people formed in Manezh Square, right under the Kremlin towers. Individuals who did not appear to be ethnically Russian were beaten at this protest; fortunately, no one was killed, but it easily could have happened. This actually led to growing concern among the country's leaders, who had previously been inclined to take a tolerant "boys will be boys" attitude toward these events. For example, this year's Russian March looked very different from that of previous years: the protestor's signs are not about ethnic Russians and immigrants, but about supporting Putin, the people, and Russia.

We also have a lot of polling information on how Russians feel about these various facets of nationalism. The annexation of Crimea, in particular, which is termed a "reunification" in official rhetoric, enjoys a uniquely high level of popular support: 85 percent of Russians currently think this was a good thing. It has almost no mainstream critics at the moment. There are

people who say it was done with undue haste and regard for the consequences, but for the most part that is as far as the criticism has gone.

However, popular support for the conflict in the Donbass is actually much thinner. To return to the subject of Professor Bunce's remarks, it is not clear why Russia would intervene in a situation like this when it seems that actually very few Russians are in favor of going too far in this direction. Now, their opinions may change, of course, but as things currently stand, only about 11 percent of Russians favor the annexation of the so-called Donetsk and Lugansk People's Republics (or the DNR and LNR): the areas controlled by the rebels. However, 52 percent of Russians polled do believe that Ukraine is an American puppet.

Given all this, is there further trouble ahead? If this stew of ethnic and national feelings and grievances is in any way associated with what has happened in Russia since the past winter (which I would argue it is), can this policy be sustained? We may not have a good basis for making a prediction, but there are certainly signals that things may soon not be so readily manageable. First of all, if Russia is going to go down the path of irredentism and privileging ethnic Russians, this could spell a lot of trouble in some other post-Soviet countries, including Kazakhstan, their closest ally. Second, individuals on the political fringes are increasingly visible. Igor Girkin, also known as Strelkov, is one of the heroes of the resistance to the Ukrainian military in Eastern Ukraine. He is a Russian citizen who volunteered in the conflict in the Donbass. After being wounded in combat, he is now seen by many as a real hero and somebody who might have a political future. One can imagine Putin would be less than enthusiastic about that. How will he manage these people? There are actually thousands of them and they have NGOs, social networks, and

other resources with which they can push their politics.

Then there is the falling ruble, which could definitely spell big trouble. This is caused in part by Western sanctions, as well as by the falling price of oil. Finally, there is the issue of Russian casualties in the fighting, which has been highlighted by the case of Russian paratroopers who died in one of the battles this past August. The government is now classifying information about these men as a state secret, but they will not be able to cover these and future casualties up. If the Kremlin extends its adventure in Eastern Ukraine and finds itself fighting again with heavy loss of life, there are going to be political consequences. These are some of the things that we should keep a very close eye on. ■

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Ocean Exploration: Past, Present, and Future

On October 12, 2014, as part of the Academy's 2014 Induction weekend program, Robert D. Ballard (President, Ocean Exploration Trust; Director, Center for Ocean Exploration; and Professor of Oceanography, University of Rhode Island Graduate School of Oceanography) told the story of his passionate career in ocean exploration. He also discussed the educational initiatives he has created to engage a new generation of scientists. A condensed version of his remarks appears below.



Robert D. Ballard

Robert D. Ballard, a Fellow of the American Academy since 2014, is Founder and President of the Ocean Exploration Trust, Director of the Center for Ocean Exploration, and Professor of Oceanography at the University of Rhode Island Graduate School of Oceanography. He is an Explorer-in-Residence at the National Geographic Society, Commissioner for the U.S. Commission on Ocean Policy, and a Senior Scientist Emeritus at the Woods Hole Oceanographic Institution.

My love affair with the ocean began very early in my life. Although I was born in Wichita, Kansas – where all oceanographers hail from – my family moved during my childhood to the warm sands of San Diego, next to one of the largest oceanographic institutions in the world:

We played golf on the moon before we went to the mid-Atlantic ridge, which is the single largest geological feature of our own planet; we have better maps of Mars than of some parts of our own ocean floor.

the Scripps Institution of Oceanography, not far from the submarine base at Ballast Point near downtown San Diego. When I was in high school, I wrote a letter to Scripps – very much a “Dear Santa Claus” letter – expressing my admiration for the institution. I’m dyslexic, so I’m sure I misspelled “oceanography,” but I gave it my best. As with so many letters, I suspected that this one was just going to vanish within the institution. Fortunately, however, a kind researcher named Robert Norris Rakestraw (who was at the time doing groundbreaking work studying CO₂ concentrations in the atmosphere) responded, informing me that Scripps had a program for rising high school juniors like me. I was lucky enough to be accepted and receive a scholarship to attend Scripps in the summer of 1959.

My luck continued at Scripps, and I was one of two students selected out of a group of thirty to go to sea that same summer. And so on the first oceanographic expedition of my life, I journeyed five hundred miles out into the Pacific Ocean to get hammered by the kind of unbelievably horrible storm that only the North Pacific can deliver. The strength of a storm and the size of its waves are determined by three characteristics:

the speed at which the wind is blowing, the amount of time that the wind has been blowing; and the “fetch,” or the distance over which the storm is raging. Because the Pacific covers a third of the planet, it is pretty hard to beat that fetch.

We secured all our gear because there was no way we could possibly work in those seas, and we put our nose into the swells, creating one giant, amazing rollercoaster ride. We made no progress: our only goal was not to sink. We were summiting these forty-foot rollers, going up and down, until out of the gloom – a rogue wave. A rogue wave occurs as the result of the merging of different weather patterns that normally cancel one another out, but in this case potentiate each other. They do not travel great distances.

I was on the bridge of the ship when it appeared, and it was clear there was no way we were going to go over the top of that wave. It totally consumed us. We took on what is called green water. Green water is the very technical term for being under the ocean – so called because you are deep enough that the water appears green. We were down there completely submerged, hoping that our residual buoyancy would pop us up on the other side. And it did.

I was thrilled. I thought this was all thrilling. I was too young to be afraid, and I became addicted, quite honestly, to going to sea. I have been to sea every year since for the last fifty-five years. I think my latest trip was my one hundred and fifty-second. That first experience was invaluable in letting me know that I loved the ocean, but I still did not know what I wanted to be.

Returning to land after the storm, we visited the University of California, Santa Barbara, where a group of geologists, led by the marine geologist Bob Norris, spoke to us about the degrees the university had to offer. I studied the programs offered at Santa Barbara and found something called the “physical science degree.” That sounded pretty lame until you read the fine print, which explained that it was a five-year degree that allowed students to major in two physical sciences and minor in two. I majored in chemistry and geology and minored in physics and mathematics. In addition to getting this broad-based science education, I also took history, anthropology, and anything else I could find the time to take. I tell children now that a university is like a supermarket at which you should eat everything possible. You might be surprised by what tastes good, even though it doesn’t sound good. Have you ever had escargot with garlic?

At that time, because UC Santa Barbara was a land-grant state university, it was mandatory for men to enlist in the ROTC. Amazingly, at Santa Barbara’s oceanside campus overlooking the Channel Islands, they only offered Army ROTC! After enrolling, I chose to become an Army officer and went off to Fort Lewis to receive my training in Army infantry. Then I was selected for Army intelligence (which is actually not an oxymoron). I received my commission but had my call to active duty delayed so that I could go to graduate school at the University of Southern California in the marine geology program. One night at USC, there

was a knock on my door and there was a naval officer standing there. He handed me an envelope (never open envelopes from officers!). The letter inside read, “Congratulations.” Maybe I shouldn’t have read past that, but it continued, “Your commission in Army intelligence has been transferred. You are now a Naval intelligence officer, and you have six days to go to the Woods Hole Oceanographic Institution on Cape Cod.” I had to turn to my Rand McNally atlas to find out where the heck Woods Hole was – because Scripps never told me there was another oceanographic institute. But that is how I ended up here in New England. I spent thirty years at the Woods Hole Oceanographic Institution, and much of the story I am about to tell you took place there.

I would like to begin this next chapter of my story now by giving you some background on the ocean floor. One of the great features of our planet is the mid-ocean ridge. It runs around our earth like the seam on a baseball for a distance of forty thousand miles; it covers almost a quarter of our planet. And yet we played golf on the moon before we went to the single largest feature of our own planet, and we have better maps of Mars than of some parts of our own ocean floor. I often ponder the reasons behind the public’s relative lack of interest in submarine features of our planet. Subconscious cultural fears are a part of it: God is up in the sky, and the Devil is down below. Plus, it is dark, which is enough to scare a lot of people. There was a great cartoon in *The New Yorker* years ago in which two women are having tea, and one turns to the other and says, “Mildred, I don’t care about the bottom of the ocean.” Clearly the ocean floor is an issue that most people do not really care about. I have come to understand that attitude, though I am also working to change it.

So, how was the incredible mid-ocean ridge formed? The foundational tenet of plate tectonics is that the earth is made up of a series

of pieces that we call “plates.” These plates are relatively thin: the lithosphere is about fifty miles thick. Yet the X and Y dimensions of a tectonic plate can be thousands of miles. Plates are in constant motion. In fact, they move in a ballet: a synchronized series of motions in which each plate is balanced and counterbalanced by the others’ behavior. The plates can do just one of three things, a fact that is lovely in its simplicity. They can either move away from one another, forming mountain ranges; move toward one another, creating head-on collisions that form great trenches; or move alongside one another, creating features like the San Andreas Fault. How does the separation of plates form mountain ranges? It rips open the earth’s outer skin. Just as your body produces blood that hardens, coagulates, and forms new tissue when you are cut with a knife, the earth bleeds its molten blood when two plates move apart and cause a tear in the lithosphere. The earth’s blood – a little hotter than ours at 1,200 to 1,400 degrees centigrade – rises from beneath the lithosphere and the asthenosphere in a constant effort to heal that wound. It then cools and forms new tissue, including mountain ranges. For this reason I’ve always emphasized, especially when talking with children, that I basically became a biologist who studies the largest creature on the planet: the planet itself.

Now, since the earth is not expanding or contracting, if it creates new tissue somewhere on its surface, it must be recycling old tissue, which is stored through a different process. That process is plate collision. Here the old plate – typically the oceanic one, because it is heavier and floating deeper in the asthenosphere – is predisposed to sink. That subduction zone refills the earth’s interior with the material it elsewhere bleeds into new surface tissue. The earth is about 4.8 billion years old. And that is why Earth is pretty compared to its sister planets, the stony inner planets of Mars, Venus, and Mercury: it has a continuous facelift.

The earth is undergoing a constant process of crustal genesis and crustal destruction. But when I entered this field no one had ever descended to the ocean floor and actually witnessed that boundary of creation. In the 1970s a group of marine geologists and other scientists, including myself, resolved to change this, undertaking the first expedition to the mid-ocean ridge. We formed an alliance with the French called Project FAMOUS (the French-American Mid-Ocean Undersea Study) and took out two different submarine vehicles.

You can follow the great rift of the mid-Atlantic Ridge all the way around the planet: from the Arctic Ocean down the center of the Atlantic, across the Indian Ocean, all the way across the Pacific, finally coming aground in La Jolla, California. There are tens of thousands of active volcanoes running along that ridge, so it is necessary to be a little careful. Fortunately, because they are under pressure and are coming from deep within the earth (and thus do not have a lot of volatiles), these are not violent explosions, and you can therefore get quite close to an active volcano in a submersible. It is also worth noting that along this ridge there are 42,000 miles of magma chambers at 1,200 to 1,400 degrees centigrade less than a mile below the surface. Only Iceland has really begun tapping that geothermal energy, which accounts for approximately 25 percent of the total energy they use.

In our early explorations to the Mid-Atlantic Ridge and the Mid-Cayman rise, we did not see a lot of life in the deep sea, because there is no light there whatsoever. In fact, most of the earth is below the euphotic zone, or the level to which light can penetrate. Most of the earth has never felt the warmth of the sun and never will. Because of this, photosynthesis as we know it cannot take place at those depths. Thus, there are not a lot of plants and there is nothing for animals to eat, so the food chain is depen-

dent upon what comes from the euphotic zone in the form of marine snow, which falls in the deep sea at a typical rate of one centimeter per thousand years. It is not a lot of energy, and it is eaten multiple times on the way down. But by the time it arrives, there is still enough to support life; furthermore, we have discovered the presence of oxygen at the deep ocean floor. Nineteenth-century Manx naturalist Edward Forbes predicted that there would be no life in the deepest parts of the ocean because oxygen decreases as a function of depth. However, due to the Antarctic Bottom Water, which carries with it oxygen from oxidizing decomposing matter, there is actually plenty of oxygen at the ocean floor to support life. All that is missing is the sun.

In addition to the active volcanism, we also noticed on the mid-ocean rise large cracks in the newly formed lithosphere – consequences of continual plate motion. Unfortunately, one of these was so big that Alvin, our Woods Hole submersible, got stuck in it at a depth of 8,500 feet. That was a bad day at the office! But we did get out. In a later expedition on a faster spreading ridge, we came across another interesting feature: giant hydrothermal vents that looked like chimneys. These giant pipe organs actually helped solve a mystery that chemists had long pondered: Why is the ocean salty? Why does it have the chemical composition that it does? One would think we would have solved this problem long ago, but chemists' best theory – water evaporates, falls as rain on land, picks up minerals, and brings the minerals into the sea – was flawed. The problem was that the chemistry of the world's oceans is not the chemistry of the rivers that flow into it.

So we had a mass-balance calculation problem, and it was not until we found these giant smokers and accounted for their chemical outputs that we were able to solve it. Incidentally, "smokers" is a terri-

ble term to use, since what emanates from them is, of course, not smoke at all. Rather, when water seeps into cracks near magma chambers close to the surface, that seawater is transformed at the hydrothermal reaction zone. It becomes completely altered by its chemical interaction with hot rocks near the magma chamber; then, driven by expansion caused by heat, it is ejected by the vents, enriching the surrounding area with minerals that determine, in part, the ocean's overall chemical composition.

When we saw the first chimney, we were totally taken by surprise: we were not even sure what it was. I suggested to the Alvin pilot, "Let's go over and find out how hot it is." "Really?" he asked, incredulously.

We tried to get within a meter or so to stick our thermometer into the jet; unfortunately for us, the updraft of the vent was literally sucking us into the thing! But after some careful piloting we stabilized and took our measurements. Our pilot then made a great scientific observation: "That's hot." When we pulled out the device, it had completely melted. The pilot then added, "You know, Bob, our window is made out of the same stuff." It was 650 degrees Fahrenheit: hot enough to melt lead, and hot enough to melt our porthole, burning our submarine and us with it. Well, after that, we put temperature sensors all around Alvin so that we would not be so surprised by these super-hot underwater environments again.

When we closely observed the jet spew out this dark smoky fluid, we saw that the fluid was actually crystal clear for about two or three centimeters after it initially exited the jet. Here, we must keep in mind that the bottom temperature around the jet is about 4 degrees Centigrade, but the solution coming out of it is around 350 degrees Centigrade. When the fluid comes out, it becomes "quenched": the solids fall out of the solution. What looks like smoke is actually microcrystals of what are called poly-

metallic sulfides. These include minerals like pyrite, chalcopyrite, and anhydrite, and they were being formed before our eyes. As a geologist, it is one thing to pick up a rock in New England that is 350 million years old, and another one entirely to watch one born in front of you.

And notably, these deposits contain commercial-grade ore of copper, lead, silver, zinc, and gold. Just consider for a moment that this is occurring along 42,000 miles of the mid-ocean ridge. Now consider that the entire oceanic crust began at that point. So the entire oceanic lithosphere, which easily constitutes 60 percent of the planet, could be as rich in ore. In fact, we observe this in the ancient pre-Cambrian shield regions of Canada. Their mines are old black smokers, as were the mines of Cyprus that drove the Bronze Age. Eighty percent of the copper of the Bronze Age came from black smokers when the closing of the Tethys pushed

the toxic fluids coming out of the hydrothermal vents. This deadly solution is laden with hydrogen sulfide, and they ingest it. Surrounding the vents, we also found giant clams. These are not recommended to eat – although one of my graduate students tried one and he is still alive. But they smell terrible, like rotten eggs.

What is really odd about both the giant clams and the worms is that they have hemoglobin in their bodies: each tube worm contains around a pint of human-like red blood. This is necessary because these creatures live in a high-flux environment that unpredictably swings from having plentiful oxygen to very little. They therefore use their blood as a sort of battery to store their oxygen for when they have a strong puff of hydrogen sulfide.

When we dissected the first giant clam, we found that it quite amazingly had no internal organs. There was no mouth, gut,

know there was an ocean there at that time (simple life began on earth about 3.6 billion years ago). We also think that the tectonic plates have been moving for over three billion years. It is very possible, then, that life on our planet began in an environment similar in some ways to that of the deep-sea hydrothermal vents. I like to tell skeptics of evolution, “If you have trouble being related to a monkey, try this!”

But despite the fact that we were making all of these amazing discoveries in the 1970s, I was having a problem. I had been diving for years in any submersible I could find. Some of them were not so good to dive in; some, in fact, almost killed me. But the primary problem with manned submersibles, at least for me, was that I spent most of my time going to work, especially when I was conducting research at unprecedented depths. When I dove into the Cayman Trough to observe the deepest volcanoes in the world, it took my vehicle six hours to descend to the bottom and six hours to resurface. That is twelve hours of commuting in a twenty-four-hour day, making my average bottom time around an hour.

Even when I was exploring the ocean floor at its average depth – which is 14,000 feet, or 4,000 meters – it took two and a half hours for me to get to work in the morning and two and a half to get home. I was able to do very little lateral exploration: the average distance traveled in a deep submersible is a mile. If you are on a 42,000-mile mountain range, you have great job security – there’s no doubt about that! But I wanted to come up with a better way of getting to work that would allow me to spend more time *at* work, so I stopped diving for a time to clear my head. During this break from exploring, I taught geology and geophysics at Stanford in 1979 and 1980. This was an exciting time to be in that neck of the woods, with the emergence of Silicon Valley and the development of all the associated technology:

In science, you begin on a journey and you do not know where it will take you; it is never a straight line.

Cyprus out of the ocean. The copper mines of Oman are all ancient black smokers. So the mineral potential is quite amazing, in addition to the energy potential.

This series of astonishing discoveries continued during an expedition to the Galapagos rift in 1977, when we came across a Disneyland of creatures completely by surprise. We did not have a single biologist on the expedition because, as they put it, “We don’t want to look at rocks.” Admittedly, they could not have known that we would stumble across these amazing oases of life. The most prominent organism we saw was the giant tube worm, which is commonly a meter to a meter and a half in length and is white with a red tip. These worms feed by sticking their feathery lungs out to ingest

or digestive system. Its entire body had been colonized by what we now call an “extremophile” bacterium: a microorganism that evolved over eons to replicate photosynthesis in the dark.

As you may know, many scientists believe that the conditions found in these deep-sea trenches closely resemble the early conditions of our planet, and that these organisms may resemble the early life on earth in some important ways. For example, modern deep-sea extremophiles’ use of chemosynthesis and storage of oxygen may resemble those processes used by very early microorganisms. Our planet has harbored oceans for a very long time. The oldest rock found on Earth is 3.8 billion years old; it is a sedimentary rock found in Greenland, so we

fiber optics, microprocessors, digital imagery. Immersed in this technological revolution, I should have said, “Hey, let’s make a cell phone.” But instead, I considered how I could use this new technology to make my job better.

Eventually I developed an idea for something I called “telepresence,” the basic premise of which is neatly illustrated by the James Cameron film *Avatar*. Just as the researchers in the film transferred their consciousness to the Na’vi avatars – those ten-foot-tall, blue, bipedal creatures – in order to explore a planet hostile to their human bodies, I wanted to transfer my spirit to the bottom of the ocean, unconstrained by the evolutionary restrictions imposed on my human body.

Most of our planet is not friendly to our bodies; we have evolved ourselves into a corner. Our bodies are limited in what they can accomplish and the environments in which they can function. But telecommunications technology allows us to build and control our avatars to carry our spirits to new domains. This has been one of my lifelong projects: to create a research station that will allow us to explore the ocean without sending our bodies down in submersibles. In the 1970s, I first approached Woods Hole, and then the National Academy, with some of my ideas. When they were skeptical about offering their support, I went to the Navy, which was interested in the project. (You all must know well that academics have two fears in academia: the first is that you do not get funding, and the second is that you do.) Once they agreed to fund me, I ran to MIT to start convincing students in the joint ocean engineering program with Woods Hole not to make their fortunes working in robotics for General Motors, but rather to help me set up my deep-sea laboratory.

So we constructed the Deep Submergence Laboratory in 1982, systematically creating the building blocks for future laboratories of

this kind. It took us thirty years of building to get to where we are today, and there is certainly more progress to be made. But the driving force still remains the same, and the end goal – to have a telepresence – is obtainable.

Those of us in those later stages of our academic careers have wisdom and finally enough time to use it, and we also have disinterested curiosity: we just want to know.

But when the Navy offered me funding for my telepresence project decades ago, it was on the condition of accepting some new jobs as a naval intelligence officer. Two nuclear submarines were lost during the Cold War: the *Thresher* and the *Scorpion*. Both had active reactors, and the *Scorpion* was carrying nuclear weapons. The Navy wanted to be sure the vessels were safe, but they did not want the Soviets to know where they were. So we needed a cover story. I said, “Have I got a cover story for you!” Because the *Thresher* sank to the west of the *Titanic* loss site and the *Scorpion* to the east, I asked, “Why don’t we tell the world I’m looking for the *Titanic*?” Well, they were furious when I actually found it, let me tell you.

The beautiful new technology we had been working on allowed us to search for the nuclear submarines with a remotely controlled vehicle system that never ascended to the surface. It could stay down for days and even weeks at a time: we really got bottom time. With this equipment (which looks relatively primitive compared to the command centers and vehicles we have today), we located the *Thresher* and the *Scorpion*, examined their nuclear reactors, and measured the radioactivity. We caught animals living in the wreckage and did radiobioassays on them: they did not have elevated levels of radioisotopes. Both reactors had scrambled

(performed an automatic emergency shut-down) and buried themselves in the deep sea mud, so there was no cause for concern.

After that, we got our cover story for the Soviets: we found the *Titanic*. With our lit-

tle remotely operated vehicle, we went up onto the bow, down the grand staircase, and then six decks in, where the chandeliers were still hanging. It was pretty amazing. A little later on, in 1986, we went inside the forward torpedo room of the *Scorpion* with our vehicle system. After the *Titanic* and the nuclear submarines, we were hooked, and we found the *Bismarck*, the *Yorktown*, and other sunken ships on behalf of *National Geographic*. In science, you begin on a journey and you do not know where it will take you; it is never a straight line. Naturally, you are always asking questions, and each discovery spawns more questions. One of these questions led me to a different kind of ship discovery entirely.

In 1987 I came to Harvard to meet with a group of archaeologists, including Larry Stager, the director of the Semitic Museum. We began to try to calculate an estimate of the number of ancient shipwrecks there would have been. We kept coming up with a figure of one million, which seemed impossibly high. But we found that when you begin your calculations early, around 4,000 B.C., it does not take you long to reach a million wrecked ships. Wondering where these millions of mariners were, I naturally looked to the Mediterranean Sea.

The dominant school of thought at the time was that ancient shipwrecks were most

likely to be found right along the shoreline, because ancient mariners' routes stuck close to the coast.

But I had some doubts about this theory. From a mariner's perspective, hugging the shoreline is dangerous: there are rocks to run into; pirates (unlike the ones portrayed in films) launched from the land when they spotted a ship passing by; and storms are much more violent in shallow water. Furthermore, most of these mariners were businessmen, and they wanted to get from point A to point B as quickly as possible. Finally, Carthaginians, as you know, did not get along with Romans. All this led me to believe that there were probably deep-water trade routes. To find them, I considered the journey from Carthage (in modern Tunisia) to Rome. Performing my most sophisticated analysis, I took a ruler, drew a straight line between Carthage and Rome, and said, "They went that way."

But how was I going to find the wrecks? I had to get in the head of a Carthaginian sailor carrying cargo to Rome. They brought a tremendous amount of wheat and wine, the latter of which was stored in large clay jars called amphorae, which are, in essence, rocks, so they have long shelf lives. I considered my sailor, who is going to Rome with a captain, five other sailors, and three thousand vats of wine. What are he and the crew going to do along the way? Do you think they will dip into the sauce? Absolutely. Are they supposed to? No. So what are they going to do with the evidence? Chuck it overboard.

If my theory was correct, they had drunk and thrown the empties over. The sedimentation rate on the ocean floor in the area I proposed to look was a matter of centimeters per millennium, so I knew what evidence I needed to search for. I decided to take a ship and a submersible out to find this highway running through a deep-water stretch. I started in Sardinia and went

perpendicular to Trapani in Western Sicily, knowing I would have to cross the route connecting Carthage to Rome somewhere, and I went looking for amphorae. I did not see a single amphora until I hit a narrow band two-and-a-half miles wide—that is how good their navigation was. Then I saw thousands of them. Once I found that highway, I just drove along it and started finding shipwreck after shipwreck.

One of the earliest ships we found was in the Skerki Delta; it was from the first century B.C. Off of the Sinai, we found a cargo of wine from a Phoenician ship that went down in 750 B.C.: the Iron Age, the time of Homer. We dated the ship by some idols we found near what would have been the living quarters. Over the next several years, having cracked the code of where to find them, we encountered an enormous number of these ships.

At many of the wreck sites we found, however, the ships themselves were gone, due to oxidization and shipworms. Even the deck of the much newer *Titanic*, for example, was eaten; all that was left were the dead shipworm shells. In a well-oxygenated ocean, wood has a life expectancy of only a couple of years before the shipworms will begin to colonize it. But one of my idols, oceanographer Willard Bascom, said that perfectly preserved ships could still be found in the Black Sea, which cannot support a shipworm population. We were barred from going there during the Cold War, but as soon as the Wall fell, I was eager to test Bascom's hypothesis. We know that ancient mariners were active in the Black Sea since pre-Classical times. Then the Greeks came in and colonized the whole area. In fact, there was an area near Sebastopol where the Greeks established a colony in order to trade with the Scythians, and it was quite an area of maritime trade. We did a significant amount of work off the coast of the city Sinop in Turkey (Sinope in Ancient

Greek), where we found ancient kilns, pottery, and amphorae.

The interesting thing about the Black Sea is that, as of 8000 B.P.E., it was a freshwater lake. Two scholars at Columbia University, Walter Pitman and Bill Ryan, propose that a massive deluge of salt water turned the Black sea into a saline body (they have also suggested this was actually the biblical flood of Noah). After the flood, the new salt water became trapped and stagnant. The water became anoxic—completely devoid of oxygen. This was also the largest reservoir of hydrogen sulfide on the planet, an environment completely inhospitable to life. All of this meant that if any wooden ships sank, there would be no organisms to eat them. Sure enough, we found perfectly preserved wooden ships on our exploratory expeditions.

On one particular ship that we found, we could actually see the carpenter's adze marks after we cleaned the mud off. It was Byzantine, about one thousand five hundred years old. When we began to unearth the artifacts themselves, they were in mint condition. We found artifacts with still-preserved beeswax drippings. And just recently, we found a classical shipwreck from 500 B.C. that contained human remains. The DNA from those shipwrecks has the potential to tell us so much more about who these ancient mariners were.

I hope I've shown you that there is much more at the ocean floor than just mud. But I also wanted to discuss with you a new educational initiative I have undertaken, which is in many ways the culmination of the journey I just described to you. I recently started a new institute at the University of Rhode Island Graduate School of Oceanography called the Center for Ocean Exploration. I also created the Ocean Exploration Trust, which is a private 501(c)(3) nonprofit incorporated in the State of Connecticut. By being president of both, I can mandate that

the two work together. There is an amazing alliance between the Trust and the University. But because the Trust can operate outside the bureaucratic constraints set by the University, our work can move at the speed of light.

Because my hero is Captain Nemo, I acquired my own ship, an East German spy ship generously donated to me in 2009. I then put money into it to turn it into a state-of-the-art exploratory platform called the *E/V Nautilus*. My next challenge was determining the source of my funding. I spent thirty years living at the trough of the National Science Foundation. As you know, we used to have a 90 percent success rate with grant proposals; we are now below 10 percent. I craved the flexibility and freedom to risk failure and follow my intuition and scientific hunches, which in my fifty-five years of exploration had always been the sources of my greatest discoveries.

I therefore set out to create an economic engine for the Center that did not require a dime from the National Science Foundation. I was not sure whether I could, but I decided I would give it a shot in my waning moments. First, I helped create the NOAA Office of Ocean Exploration with a budget of \$4 million. Then I was asked by President George W. Bush to serve on the U.S. Commission for Ocean Policy, and we reinforced the need for ships specifically dedicated to exploration. Now the Office of Ocean Exploration budget is at about \$28 million. Some of that budget goes to my Center for Ocean Exploration. But, as my father told me years ago, to have twelve masters is to have none: the key to maintaining intellectual freedom is to let no one own more than 20 percent of you. For that reason, I have a diversified portfolio, with funding coming from the government as well as from a variety of private sources.

After I stabilized my funding, I put together a team consisting of two types of

players. The first is graduate students and postdocs. The majority of them are actually graduate students, because they have nothing to lose with change, and change threatens power. The other part of the team is the advisory board, which comprises those I lovingly call the old farts. To be in my advisory board, you have to struggle to answer the following question: when did you get

We live in a star-centric society, so it is crucial that the STEM fields have visible role models. The key, I believe, is to present our job as the most exciting one in the world.

tenure? Then you are in! I do not work in the middle of the scientific estate. I work on the edges of it, with people in the very early stages of their careers and in the very advanced stages. Those of us in those later stages have wisdom and finally enough time to use it, and we also *just want to know*. We do not have a dog in the fight anymore. We do not care whether we are the first author on a paper. We are past that. We just want to know.

One of the primary projects of the Ocean Exploration Trust is a program that offers groups of scientists access to our *E/V Nautilus* research ship (which is owned and operated by the Trust). The Center for Ocean Exploration at the University of Rhode Island Graduate School of Oceanography also takes a strong supportive role in this initiative. In December 2014, in San Francisco, eighty-eight groups of scientists proposed the projects they would undertake if given access to the *Nautilus*. We will soon select a group and make their proposal a reality. It is a community-based and -driven process, and all the data will be open-source, made public as it is collected. A discovery could be made at any moment, so all around the

United States, we will have teams of scientists willing to be awakened at two o'clock in the morning by data streaming into their smartphones from our laboratory. The concept we hope to execute is similar to running an emergency room of a hospital: we have no idea what the ambulance is going to deliver on Sunday morning. We are on-call twenty-four hours a day.

Right now, the projects of the Center for Ocean Research are focusing on using our technology to explore our own country. We are looking for oil and gas, mineral resources, new fisheries, rare earth metals, and, of course, natural wonders that need to be protected. All of these projects require state-of-the-art technology. We have, for example, powerful mapping systems on the hull of our ship that allow us to digitally map new ocean terrain, including the textural characteristics of the ocean floor. This can be done at full engine speed, so we have been covering ground rapidly. We also have remote-controlled vehicle systems that can operate twenty-four hours a day, controlled from an amazing staffed command center operated in shifts around the clock. We have pilots, copilots, navigators, video engineers, closed-loop robotic controls, and force feedback manipulators (controls that allow a pilot to “feel” what a remote-control robot is doing). This has already led to some exciting discoveries: new extremophiles, fish that can walk, a sunken German U-Boat in the Gulf of Mexico.

We use these resources to create a network *off* the ship and outside of the com-

mand center of teams that will interpret all of the data. In Rhode Island, we have the Inner Space Center and the Center for Ocean Exploration, all run by my students. Our hope is to facilitate the creation of multiple command centers. With \$15,000, a department at a university can create a command center, and scientists can then enter the game with their students, using our technology to remotely conduct research and experiments.

I would now like to speak about our education program and how I try to capture the imagination of the next generation. I believe that outreach is less about science and more about scientists as role models. We live in a star-centric society, so it is crucial that Science, Technology, Engineering, and Mathematics (STEM) fields have visible role models. I recently did a presentation at Lamar University in Beaumont, Texas, on ocean exploration. Ten thousand five hundred young people showed up. The president of the university informed me that I broke an all-time attendance record set by Sir Elton John. The key, I believe, is to present our job as the most exciting one in the world.

Because Lewis and Clark were the “Corps of Discovery,” we call the Center of Ocean Exploration crew the “Corps of Exploration.” I mandate that 55 percent of the Corps’ positions of leadership authority be occupied by women, and that the composition of the Corps truly reflect the demographics of our country. Children looking at the individuals in our organization must see their faces as they might look twenty years out. If they do not, a message is sent that they cannot play, will not be let in. This is one of our top priorities, one to which we have dedicated an incredible amount of effort. All individuals in the Corps wear uniforms, which my academicians had a little trouble with, but I tell them they are meant to reflect that we are all team members –

The composition of my Corps of Exploration truly reflects the demographics of our country. Children looking at the individuals in our organization must see their faces as they might look twenty years out.

there are no titles within the Corps. There are only three Ph.D.s in the group, and the team is composed of a great variety of players who each fill a role essential to the operations of the Corps. A child needs to know that in the world of science, there are many positions to play, and more opportunities than are apparent in academia. In our lab, for example, we have high school seniors, college students, graduate students, post-docs, and Ph.D.s working alongside one another. I have received literally tens of thousands of letters from children interested in ocean exploration, and we answer every one of them – because I still remember the letter I wrote and the monumental importance of the response I received.

In short, our educational outreach goes – to borrow from Buzz Lightyear – from kindergarten to infinity and beyond. Students are very young when they first come out on our ship. The scientist I have selected to succeed me in the Corps, Katy Croff Bell, is an excellent example of this. She is an MIT graduate in engineering whom I met in 1999. She did her master’s degree in archaeology, then was a student of mine for seven years, and finally I hooded her two years ago with her Ph.D. in geology and geophysics. She takes no prisoners. A young student inspired by the Corps of Explorers who became a great explorer and role model herself: Bell represents to me the very hopeful future for the field of ocean exploration, and I expect her to inspire many more to pursue the STEM disciplines.

One of the added benefits of using telepresence technology to conduct live, inter-

active exploration from ashore is that we can involve a large number of students and teachers in the process. Seeing scientists in action as they explore the unknown – particularly when they make an important new discovery and act like children opening a birthday present – humanizes what many students may have seen as a dull process too complicated to fathom.

Helping the next generation of students excel in STEM skills is critical to our ability to deal with the difficult challenges humanity currently faces. Using the excitement of exploration and discovery to motivate students to “go the extra mile” has proven effective. ■

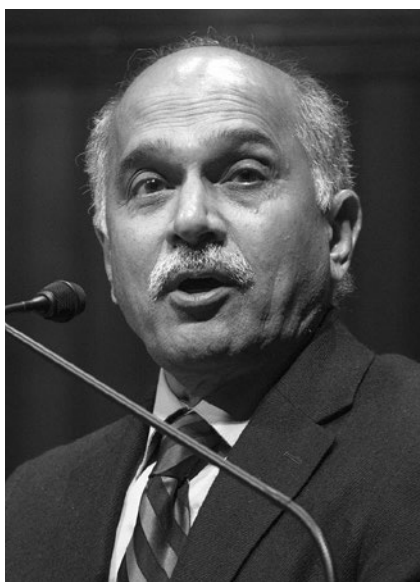
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To view or listen to the presentations, visit <https://www.amacad.org/induction>.

2014 Induction Ceremony Class Speakers

On October 11, 2014, the American Academy inducted its 234th class of Fellows and Foreign Honorary Members at a ceremony held in Cambridge, Massachusetts. The ceremony featured historical readings by **John Fabian Witt** (Yale Law School) and **Linda Darling-Hammond** (Stanford University), as well as a performance by the Boston Children’s Chorus. It also included presentations by new Fellows **Ramamurti Shankar** (Yale University), **Diana H. Wall** (Colorado State University), **Sherry Turkle** (Massachusetts Institute of Technology), **Mary Kelley** (University of Michigan), and **John W. Rogers, Jr.** (Ariel Investments, LLC). Several of these presentations appear below.



Ramamurti Shankar

Ramamurti Shankar is the John Randolph Huffman Professor of Physics and Applied Physics at Yale University. He was elected a Fellow of the American Academy in 2014.

I am happy to be here today to talk to you on behalf of Class I, the Mathematical and Physical Sciences. I have chosen a topic I hope will be of interest to everybody: online education.

My interest in this topic was sparked a few years ago, when I was asked to teach for the first time an introductory physics course to a very large class of freshmen at Yale, composed mainly of “nonbelievers” like economists, social scientists, historians, and pre-meds. I was concerned: the

introductory textbooks had become thicker since the time I was a freshman, and when I looked at the students in my class, none of their heads were three times as big as mine. The other problem was the diversity of the class: I didn’t know how to get these people interested in relativity and quantum

online. He asked if I had any objections to having my class videotaped. I told him that I had yet to meet a camera that I didn’t like. So videographers came and filmed all the lectures, and a few years later, the entire course became available on the Open Yale Courses site. It is also available on YouTube

One might argue that video lectures are a threat to professors’ jobs, but an engaging presentation is not the only requirement for teaching. Teachers console you, they criticize you, they evaluate you, and they are there for the whole process.

mechanics. Could I really tell the future doctors that relativity would be useful if one of their patients began running away from them at the speed of light? Must future pediatricians understand that their patients will not sit still because the uncertainty principle prevents tiny objects from having a definite location and velocity?

I decided instead to simply tell them why I like physics: the power of its mathematical underpinnings and the breadth of the universe that it is able to describe. I found this proselytizing to be very pleasurable, and I taught that course several more times. During this run, Dean Peter Salovey, now President of Yale, told me about a program funded by the Hewlett Foundation with the purpose of videotaping some Yale courses and putting them

and iTunes, and all the course materials – including problems, exam solutions, and lecture transcripts – are available on Yale’s website. These lectures have been seen by many people: young and old, students and teachers, people here and abroad.

I was very pleased with all of this until I had a conversation with David Gross, one of my current colleagues at the Institute for Physics and a well-known physicist who is quite supportive of my other endeavors. He asked me if I had ever worried about what open courses will do to us as professors. I replied that I had thought about it, and it didn’t worry me. I didn’t see the problem with giving the complete Yale experience (except for the sticker shock) to as many people in the world as want it. Gross argued that given the high cost of higher education,

administrators may be tempted to use these online videos as a substitute for faculty, letting many of them go, telling the students to simply watch the video, and hiring a few temporary faculty to come and do the sections. Of course, if that really did happen, I agree that it would be a catastrophe. We should try our best to fight against that future, and at the very least, we should make sure that we carefully study whether this approach to education is even viable before we plunge into it.

In the meantime, however, I want to give a couple of reasons of my own for why I do not think these videos are a threat to faculty members in any university – big or small, public or private. These points are the result of discussions with my colleague Dieter Vollhardt and his wife Jutta Muttenthalmer.

First, if you were to carry this argument further, one could even argue that a good book is a threat to all teachers. Why not simply tell students to read my *Principles of Quantum Mechanics* and fire me? On the other hand, one might argue that a video is more of a threat because it creates the same classroom experience instructors might provide. I disagree with that. An engaging presentation is not the only requirement for teaching somebody. If that were the case, we could leave the education of our young children in the hands of Big Bird. Why don't we do that? Because Big Bird talks, but Big Bird doesn't listen. So Big Bird does not know what you, a student, are struggling with. And that is precisely where teachers and parents come in: they give you a tailor-made introduction to the subject. They know where you get confused; they know when to explain something differently. They console you, they criticize you, they evaluate you, and they are there for the whole process. That is the role of the teacher at both the smaller teaching universities and the research universities. So I do not think video lectures could supplant the student-teacher relationship.

Finally, I think a new pedagogical method that I have recently embraced may actually make this discussion irrelevant: the idea of a *flipped classroom*. In a flipped classroom model, the students do the reading, complete the exercises, and even watch a video of the lecture the day *before* class meets. Actual class time is primarily spent on discussing problem sets and working with individual students. I plan to teach my own course next semester using the flipped classroom model, and I plan to use my own lecture videos. If I thought those videos were the last word in teaching, I would not show up for class. But instead, I will be there, working as hard as everybody else. When we meet next, I will tell you how all that went.

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Diana H. Wall

Diana H. Wall is University Distinguished Professor, Director of the School of Global Environmental Sustainability, and Professor of Biology at Colorado State University. She was elected a Fellow of the American Academy in 2014.

It is an honor, and frankly, scary, to try to represent the enormous field of biology in this speech. Rather than attempt to do so, I will talk about a shift that I have seen in biology over the course of my career. As we begin to tackle big issues like climate change, we have seen biology expand to include collaborations across disciplines and comparisons on a global scale that we did not see to this extent even ten or twenty years ago.

I first went to the Antarctic dry valleys in the late 1980s. The valleys constitute one of the most extreme desert ecosystems. It is one of the coldest, windiest, driest places on earth; and there is nothing flying, crawling, or green that you can see. No insects or plants live aboveground. Working there is like being in a freezer, and it looks a lot like Mars, except with less color. In a paper published in the 1970s, scientists described these

valleys as having sterile soils with no life. My colleagues and I had worked in hot deserts in the United States, and our findings led us to question that assumption. When we finally went to Antarctica, we took soil samples back to the lab and examined them under a microscope, and as you may have heard, we quickly found nematodes, or roundworms; three to four different species. That is what I find so fascinating about soil: it is an unseen universe that contains nearly as many groups and phyla belowground as we see aboveground, most of which are unknown and undescribed. Antarctica is a perfect place to

the atmosphere – that is not a question. We hear about iconic species, such as the polar bear and the bald eagle, that are threatened by climate change, or that are being forced to adapt in response to it. But it is not just those adorable species aboveground that are affected by climate change. It turns out that even species that are so resilient that they can survive the harsh environment of the Antarctic dry valleys are also struggling to adapt to a changing climate.

This is one of the most pressing issues in biology today. We must understand the myriad relationships between climate

As our knowledge of science and biology grows, we see more and more opportunities to work across disciplines to tackle pressing global challenges such as climate change, water conservation, and food security.

study individual species, because there are far fewer species in the soil there than in any other place on earth.

Let me pause here to tell you a little bit more about nematodes. They live in soils everywhere around the world. They are tiny invertebrate animals, smaller than your eyelash and invisible to the naked eye. Though they live in soil, they are aquatic: they live in the water films around soil particles. One single tablespoon of soil contains many different species and very high numbers of nematodes. In fact, that tablespoon can have anywhere from ten to five thousand nematodes, representing between ten and one hundred different species.

So how does the discovery of nematodes in Antarctic soil relate to the big issues that we face today? We know that the climate is changing. We are aware of the increasing level of CO₂ and other greenhouse gases in

change and different types and sizes of species. I will share with you the story of one species that I have studied for twenty-five years in Antarctica, because we know that it is responding to climate change. The dominant nematode in the Antarctic dry valleys today is *Scottinema*, which lives in the driest soils (but not in the wettest soils near glacial melt streams or frozen lakes). It feeds on bacteria, and I like to call it the Rambo nematode because it's very tough and resilient. It is the top dog, so to speak, in this ecosystem. We wanted to know if *Scottinema*'s populations would be affected by changes in temperature and moisture. We decided to conduct experiments to see how the changes would affect these soil ecosystems. What we found is that decreasing the moisture and the temperature even slightly led to a dramatic shift: *Scottinema* populations declined and a different species thrived.

Now, this is where people usually ask me, “As fascinating as nematodes are, why should I care which type is dominant in such a remote place?” Well, we conducted field experiments that showed that *Scottnema* is responsible for about 7 percent of soil carbon cycling. We know that a 65 percent decline in *Scottnema* over a ten- to twelve-year period could reduce soil carbon cycling by nearly one-third. What scares me is that we do not know if the species that will replace this nematode will continue to store carbon or will release even more.

This story is bigger than soil carbon storage in Antarctica: soil plays a vital role in every ecosystem on earth, and we know very little about the huge variety of species that live in soil. Just as plants and animals above-ground have vastly different functions in their ecosystems, each species belowground plays a different role in storing carbon, cleansing water, ensuring soil fertility, and regulating pests and disease, among many other benefits. My colleagues and I have analyzed and studied soil in places as diverse as Kenya, the plains of the Midwest, and, most recently, Central Park in New York City, and we have found a stunning variety of ecosystems. Precisely because there are so many kinds of animals and microbes in every handful of soil, it is difficult for an ecologist to answer basic questions about the role of a single species in soil, though we may need to know these answers for any study of climate change.

This brings me back to the idea that the field of biology is changing. I regularly work with glaciologists, geochemists, soil biogeochemists, political scientists, historians, physiologists, and other biologists and ecologists. This is typical of the work that climate change scientists are doing to find out how the different organisms in an ecosystem are responding to a changing climate and whether it matters. As our knowledge of science and biology grows, we see more

and more opportunities to work across disciplines to tackle the most pressing global challenges of climate change, urbanization, water conservation, and food security. For me, biology is about more than watching a struggle between two nematodes in one of the most dramatic settings on earth – although I do like to do that. It is about understanding the world below our feet and the role it plays in the health of our planet and its people.

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Mary Kelley

Mary Kelley is the Ruth Bordin Collegiate Professor of History, American Culture, and Women's Studies at the University of Michigan. She was elected a Fellow of the American Academy in 2014.

I am delighted to be here. It has been said, but it bears repeating: I feel extraordinarily fortunate to keep company with the astonishingly articulate, intelligent, and accomplished individuals that constitute this academy. And on a more personal note, I would like to acknowledge my husband, Philip Pochoda, who in so many ways—with his energy, his wit, his incredible intelligence—has illuminated my life. For me, this is in many respects an honor we share.

At this year's presentation of the National Humanities Medals, President Barack Obama stepped to the podium and boldly pronounced, "We rely on the humanities. We need them to live." Discounting an obvious rhetorical excess, I fully endorse the passion and the sentiment of the President's statement. I similarly celebrate the Academy's recently published report *The Heart of the Matter*, which situates the humanities

Reading fashions makers of public opinion; it is the foundation for critical thought and academic scholarship; it is the occasion for a solitary commingling of shifting subjectivities of readers and texts that kindles the imagination and leads to unexpected outcomes.

as "the keeper of the republic: a source of national memory and civic vigor, cultural understanding and communication, individual fulfillment and the ideals that we hold in common."

And yet for all these aspirational ideals, these days it appears that the word "humanities" can only be publicly deployed when embedded in a gloomy compound noun, such as "humanities crisis" or "crisis of the humanities" (we might use the acronym C.O.T.H. here). The mounting evidence for C.O.T.H. is perhaps most stark in higher education, where we see shrinking enrollments, elimination of departments, and removal of basic requirements. The Academy's *Humanities Report Card*, published last year, alerts us to larger social challenges and reveals, perhaps, the further divergence of C. P. Snow's two cultures. The report demonstrates that the increasingly unbridled gap between average math and verbal scores on the SAT is growing. Another statistic suggests why: less than 30 percent of twelfth-grade students are proficient in writing, history, and civics. There is also the increasing tendency to equate learning with earning, a conviction most risibly expressed by Florida's governor Rick Scott, who argued that public university students majoring in the humanities ought to pay higher tuition, because their lower salaries upon graduation demonstrate their lesser value to society.

And yet, as commentators have noted, the People's Republic of China, which had until

recently paid scant attention to the humanities, has now recognized that they play an important role in fostering creativity and imagination, critical thinking and argumentation. These are the very qualities essential to the Florida governor's objective: the pursuit of economic prosperity. Further, the humanities have been recognized as crucial to the continued advancement of America's democracy. The nation's founders, as *The Heart of the Matter* argues, understood that the success of the Republican experiment depends on a citizenry able "to think critically, understand their own history, and give voice to their beliefs while respecting the views of others." The humanities, both in theory and practice, encompass a broad range of subjects (including history, literature, religious studies, and philosophy), perspectives, hermeneutical strategies, and methodologies. Where they all converge is in the practice of individual reading: a personal act, but one that promotes broad national and cultural objectives, while also having incalculable informative, transformative, subjective consequences.

Reading has multiple varieties and dimensions. In the essay collection *The Humanities and Public Life* (2014), editor Peter Brooks argues for a "close, intense, disciplined reading." Close, intense, and disciplined is the Holy Trinity in which many of us have been schooled. However, there are other, more common (and, I would add, more expansive) strategies for reading,

including the “uncritical reading,” which literary critic Michael Warner observes in students who walk into his classes. They read in all the ways that are not appropriate, at least by Brooks’s definition. Warner tells us: “They identify with characters. They fall in love with authors. They warm with pride over the national heritage. They thrill at the exotic and take reassurance in the familiar. They laugh, they cry. They lose themselves in books, distracting themselves from everything else.” These students are also what scholar Michel de Certeau calls “poachers”: readers who intervene to create a plurality of meanings beyond those intended by either authors or publishers.

Theodore Sedgwick, one of the founders of our Academy, told his young daughter Catharine that she should “find it in [her] power to devote [her] mornings to reading.” Sedgwick reminded his daughter that hers was a privileged position: “There are few who can make such an improvement.” The woman who would become a leading novelist in the early nineteenth century heeded her father’s counsel. As Catharine put it, the “love of reading” her father instilled in her became her education.

Exactly the same can be said about Margaret Fuller, antebellum America’s most prominent woman of letters. Poet, editor, and literary critic, Fuller was schooled by her father. In addition to drilling her daily in Latin and Greek, Timothy Fuller welcomed his eldest daughter into his library, where she immersed herself in Shakespeare, Cervantes, Moliere, Fielding, Smollett, and Scott. Reading Shakespeare on a Sunday afternoon led to an emotionally charged encounter. “Shakespeare? That won’t do; that’s no book for a Sunday. Put it away,” Timothy instructed his daughter. The eight-year-old did – and did not. Initially she placed *Romeo and Juliet* on the shelf, albeit without taking a substitute. But she yielded to desire and retrieved the volume,

managing to read half the play before her father asked the same question and received the same answer. Incensed by her disobedience, he immediately ordered her to bed. That Fuller no longer had the text at hand mattered little, if at all: “Alone,” she said, “in the dark, I thought only of the scene placed by the poet before my eye, where in the free flow of life, sudden and graceful dialogue, and forms seen in the broad luster of his imagination gave just what I wanted. My fancies swarmed like bees, as I contrived the rest of the story: what all would do – what say? Where go?”

Other readers may not appropriate the text to the same degree as Fuller, but they read with the same eye to self-defined needs and desires. Acting with a similar agency as that of Fuller, they “poach” to create meanings with which they fashion subjectivities and form themselves into autonomous individuals.

Like her more privileged counterparts, Rose Cohen looked to books to help her craft a more expansive and meaningful life. For this daughter of Jewish immigrants, literacy alone was a significant achievement. Spending her childhood in a small village in northwestern Russia in the late nineteenth century, Cohen had had available only a few volumes in Yiddish. For her, as for Sedgwick and Fuller, reading was the means to education; and, as it has been for many immigrants then and now, it was also a means to assimilation and orientation. Later, on the Lower East Side in the early twentieth century, “reading material was not so limited”: “A flying newspaper in the street, a crumpled advertisement – I would smooth it out tenderly and carry off home, happy in the expectation of what awaited me. . . Just to read became a necessity and a joy,” as Cohen recalled. “Necessity” derived from the need for refuge from the severe constraints of life on the Lower East Side. “Joy” spoke to the sense of possibility experienced in reading.

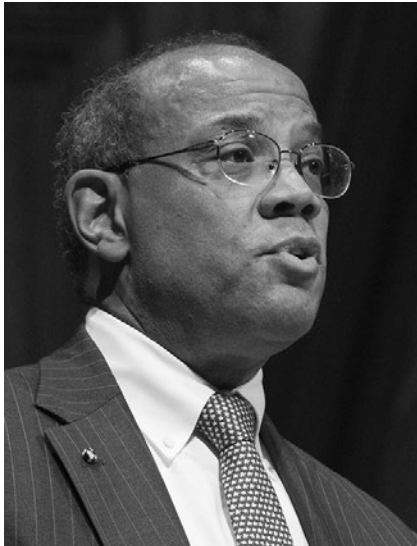
From there, Cohen moved on to Charles Dickens and other British and American novelists; this led to a formal education at the socialist Rand School; and finally, Cohen wrote her autobiography *Out of the Shadow*, which was first published in English and subsequently translated into French, Danish, and Russian.

The practice of reading serves multiple purposes. It can open readers’ lives outward, fashioning makers of public opinion, as with Sedgwick, Fuller, and Cohen. It is the foundation for critical thought and academic scholarship. It can also turn individuals inward, inviting them into communion with a fully realized world set apart from life’s external circumstances. Reading is the occasion for a solitary commingling of shifting subjectivities of readers and texts that kindles the imagination and leads to unexpected outcomes. The spontaneous idea, the fleeting connection, the pleasure of recognition, the discovery of the unanticipated dimension of self – all are generated through intense encounters that are shaped by affect and driven by interest.

In short, then, the purposes and strategies are as varied as the individual readers, but the sustained and sustaining engagement with reading is, as literary critic David Ulin tells us, “a way to map, or imprint, certain emotional states and experiences. It is a template by which we come to a reckoning with life.”

At the end of the day, then, C.O.T.H. or no C.O.T.H., as long as reading is cherished and nurtured, whether in the traditional analog or the new digital formats, I would suggest on an optimistic note that the humanities and their progeny will remain secure.

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John W. Rogers, Jr.

John W. Rogers, Jr. is Founder, Chairman, Chief Executive Officer, and Chief Investment Officer of Ariel Investments Co., LLC. He was elected a Fellow of the American Academy in 2014.

Thank you all for the honor of being inducted into this esteemed Academy and for the privilege of representing Class V: Public Affairs, Business, and Administration. However, I think the honor truly belongs not to us but to the people who led us here, the mentors and role models who pushed and supported us and believed in us every step of the way. So I would like to dedicate this moment to my father, who passed away this year at age ninety-five. My father believed in backing up his convictions with actions, as evidenced by his service as a Tuskegee Airman, during which he flew over 120 missions. But he also believed in teaching me about the value of money, which meant that each year on my birthday and Christmas, I didn't get toys; instead, my father gave me certificates of stock. (You could imagine the look on my face the first time that happened.)

But I was truly lucky to have a father who was so far ahead of his time. It is hard to believe that a man who grew up as an orphan during the tough times of the Great Depression was able to make himself more financially literate than most American adults are today. But he worked hard at it, because he believed that financial literacy is not just about numbers and money; it is fundamentally about empowerment and opportunity. Now, as my colleague Mellody Hobson is

about learning how to invest in the market or manage student loans: it also empowers us as citizens in a democracy, allowing us to better participate in critical policy debates that could shape our future for decades to come. It helps us hold our leaders in government and business accountable. Today, as the economic recovery remains hobbled by historically high wage inequality, a public school curriculum that teaches financial literacy can help address the growing wealth

Greater financial capability and literacy is not just about learning how to invest in the market or manage student loans: it also empowers us as citizens in a democracy, allowing us to better participate in critical policy debates that could shape our future for decades to come.

fond of pointing out, if you poll Americans on what the S&P 500 is, most people would respond that it is a racetrack. The truth is, these financial acronyms, from TARP and SIFI to IRAs and 401(k)s, really do matter. They factor into our individual fortunes and national prosperity in profound ways.

Finance is simply too important to remain the domain of a privileged few, especially today. It is no longer enough for us to coast along on a basic understanding of savings accounts, FICO scores, and credit cards. As pensions are rapidly being replaced with defined-contribution plans, Americans now find themselves having to act as their own portfolio managers. Furthermore, the economic crisis that devastated millions did not merely stem from an imbalance of power between the financial industry and the rest of America; it was also fueled by an imbalance of knowledge. Greater financial capability and literacy is not just

gap that persists in most urban and minority communities.

In my role as Chair of President Obama's Advisory Council on Financial Capability, I have worked with Education Secretary Arnie Duncan, Treasury Secretary Tim Geithner, and many others to encourage financial education within our public schools, starting as early as first grade. Part of the Council's work led the Department of Education to participate in a global study conducted by the Organisation for Economic Co-operation and Development to measure the financial literacy of our fifteen-year-old students compared with that of their peers around the world. This study was the first of its kind, and conducting it was harder than you might think. The data show that our students, from the richest country in the world, were just average in terms of financial literacy, falling well behind students from China, Australia, and parts of Europe.

Getting our citizens to the head of the pack is not just a job for our government: we believe that business leaders and financial executives can partner with urban schools to enhance financial education and provide role models and critical mentors.

That is exactly what we have been doing in Chicago. I'm proud to note that my company has been at the forefront of this effort through our public magnet school, the Ariel Community Academy. For the past sixteen years, our program has provided students in grade school with real money to invest in real stocks, giving them the same opportunities that my dad gave me.

We have also been able to introduce all the Academy's students to financial analysts and take them to annual meetings, such as the McDonald's annual meeting, every year. Lastly, we have created an innovative curriculum that makes investment terms like "P/E ratios" and "beta" common terminology for all students.

Our work has also inspired over forty financial institutions in the Chicago area. Working with the Big Shoulders Fund to invest in stock-market education programs in local schools, and through the work of the President's Council, we are learning about an incredible array of impactful programs across the country whose successes we hope to help replicate wherever we can.

The long-term values of these initiatives, especially those in our public schools, will accrue even faster than compound interest. They can help empower our children with greater knowledge, stronger math skills, and the opportunity to take greater responsibility for their financial futures. They will help more students grow up to be business leaders and entrepreneurs, which in turn creates more economic stability and, critically, more jobs for urban communities. And they will mean a more informed citizenry, which will help ensure that our uniquely

democratic vision of capitalism continues to drive America's greatness.

Today, I consider myself incredibly fortunate to be part of this remarkable community. After all, it was one of this group's earliest members, Benjamin Franklin, who instructed us that "an investment in knowledge always pays the best interest." ■

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Select Prizes and Awards to Members

National Medal of Arts, 2013

Maxine Hong Kingston (University of California, Berkeley)

Albert Maysles (Maysles Films, Inc.)

Billie Tsien (Tod Williams Billie Tsien Architects, LLP)

James Turrell (Turrell Trading Company)

Tod Williams (Tod Williams Billie Tsien Architects, LLP)

National Humanities Medal, 2013

M. H. Abrams (Cornell University)

David Brion Davis (Yale University)

William Theodore de Bary (Columbia University)

Darlene Clark Hine (Northwestern University)

Anne Firor Scott (Duke University)

Nobel Prizes, 2014

Chemistry

William E. Moerner (Stanford University)

Economic Sciences

Jean Tirole (Institut d'Economie Industrielle)

National Medal of Science

Bruce Alberts (University of California, San Francisco)

Robert Axelrod (University of Michigan)

May Berenbaum (University of Illinois at Urbana-Champaign)

David Blackwell (University of California, Berkeley)

Alexandre J. Chorin (University of California, Berkeley)

Thomas Kailath (Stanford University)

Judith P. Klinman (University of California, Berkeley)

Jerrold Meinwald (Cornell University)

Burton Richter (Stanford Linear Accelerator Center; Stanford University)

Sean C. Solomon (Columbia University)

National Medal of Technology and Innovation

Edith M. Flanigen (Universal Oil Products, LLC)

Arthur D. Levinson (Calico)

Cherry A. Murray (Harvard University School of Engineering and Applied Sciences)

Presidential Medal of Freedom

Tom Brokaw (NBC News)

Mildred Dresselhaus (Massachusetts Institute of Technology)

Abner Mikva (University of Chicago Law School)

Robert Solow (Massachusetts Institute of Technology)

Other Awards

Andreas Acrivos (Stanford University) was named a Stanford Engineering Hero.

Rolena Adorno (Yale University) has been awarded the Modern Language Association's Lifetime Scholarly Achievement Award.

Richard B. Alley (Pennsylvania State University) is the recipient of the 2015 BBVA Foundation Frontiers of Knowledge Award in Climate Change.

C. David Allis (Rockefeller University) was awarded a 2015 Breakthrough Prize in Life Sciences.

Victor Ambros (University of Massachusetts Medical School) was awarded a 2015 Breakthrough Prize in Life Sciences.

Arvind (Massachusetts Institute of Technology) has been elected a Foreign Fellow to the India National Academy of Sciences.

Norman R. Augustine (Lockheed Martin Corporation, ret.) was named to the 2014 STEM Leadership Hall of Fame.

David Awschalom (University of Chicago) is the recipient of the 2015 Julius Edgar Lilienfeld Prize, given by the American Physical Society.

Keith Baker (Stanford University) received an Award for Scholarly Distinction from the American Historical Association.

Tania Baker (Massachusetts Institute of Technology) received the Arthur Kornberg and Paul Berg Lifetime Achievement Award from the Stanford University Medical Center Alumni Association.

Cornelia Bargmann (Rockefeller University) received the 2015 Benjamin Franklin Medal in Life Sciences.

Ben A. Barres (Stanford University School of Medicine) was elected to the Institute of Medicine of the National Academies.

Gordon Bell (Microsoft Corporation) is the recipient of the 2014 IEEE Computer Society Seymour Cray Computer Engineering Award.

Leo Beranek (Westwood, MA) was inducted into the Massachusetts Broadcasters Hall of Fame.

Ben Bernanke (Brookings Institution) received the 2014 CME Group Melamed-Arditti Innovation Award. He was also selected as a member of the American Finance Association Society of Fellows.

Martin J. Blaser (New York University) is the 2014 recipient of the Alexander Fleming Award from the Infectious Diseases Society of America.

Michael R. Bloomberg (Bloomberg L.P.) was named an Honorary Knight of the British Empire.

Sheila E. Blumstein (Brown University) has been awarded the Silver Medal in Speech Communication by the Acoustical Society of America.

Robert A. Brown (Boston University) has been named a Fellow of the National Academy of Inventors.

Stephen Buchwald (Massachusetts Institute of Technology) is the recipient of the 2015 BBVA Foundation Frontiers of Knowledge Award in Basic Sciences.

Emanuel Candes (Stanford University) was awarded the 2015 AMS-SIAM George David Birkhoff Prize in Applied Mathematics.

Lewis Clayton Cantley (Weill Cornell Medical College; New York-Presbyterian Hospital) was elected to the Institute of Medicine of the National Academies.

Fernando Henrique Cardoso (Brown University) was selected as the Brazilian Recipient of the 2015 Person of the Year Award by the Brazilian-American Chamber of Commerce, Inc.

Brian Charlesworth (University of Edinburgh) has been awarded the Genetics Society of America's Thomas Hunt Morgan Medal.

Roz Chast (*The New Yorker*) was awarded a Kirkus Prize by the *Kirkus Reviews*.

Geoffrey Coates (Cornell University) received the ACS Award in Applied Polymer Science, given by the American Chemical Society.

Peter Crane (Yale University) was awarded the 2014 International Prize for Biology by the Japan Society for the Promotion of Science.

Mahlon R. DeLong (Emory University School of Medicine) received a 2014 Lasker-DeBakey Clinical Medical Research Award.

Stanley Deser (Brandeis University) was awarded the Einstein Medal by the Albert Einstein Society. He shares the prize with **Charles Misner** (University of Maryland).

Joseph DeSimone (University of North Carolina at Chapel Hill; North Carolina State University) was elected to the Institute of Medicine of the National Academies.

Jennifer Doudna (University of California, Berkeley) was awarded a 2015 Breakthrough Prize in Life Sciences.

Catherine G. Dulac (Harvard University) is the recipient of the 2015 Pradel Research Award from the National Academy of Sciences.

Richard A. Epstein (New York University School of Law) received the 2014 Marshall-Wythe Medallion from William & Mary Law School.

Alex Eskin (University of Chicago) was named a 2014 Simons Investigator in Mathematics by the Simons Foundation.

Christopher Field (Carnegie Institution for Science; Stanford University) was awarded the Roger Revelle Medal from the American Geophysical Union.

Joseph J. Fins (Weill Cornell Medical College) was named an Académico de Honor of Spain's Royal National Academy of Medicine. He was also awarded the Patricia Price Browne Prize in Biomedical Ethics from the University of Oklahoma College of Medicine.

Matthew Fisher (University of California, Santa Barbara) was awarded the 2015 Oliver E. Buckley Prize by the American Physical Society.

Athol Fugard (Port Elizabeth, South Africa) is a recipient of the 26th Praemium Imperiale.

Howard Gardner (Harvard Graduate School of Education) was awarded the 2015 Brock International Prize in Education.

Andrew Gordon (Harvard University) was awarded the Order of the Rising Sun, Gold Rays with Neck Ribbon, by the Japanese government.

Jeffrey I. Gordon (Washington University in St. Louis) received the University of Pittsburgh's 2014 Dickson Prize in Medicine.

Ian Hacking (University of Toronto) was awarded a 2014 Balzan Prize.

Robert Pogue Harrison (Stanford University) was named Chevalier de l'Ordre des Arts et des Lettres by the French government.

Siegfried S. Hecker (Stanford University) received the 2014 Arthur M. Bueche Award from the National Academy of Engineering.

Steven Holl (Steven Holl Architects) is a recipient of the 26th Praemium Imperiale.

Thomas C. Holt (University of Chicago) was awarded a Wilbur Cross Medal from the Yale Graduate School of Arts and Sciences.

Susan Band Horwitz (Albert Einstein College of Medicine) is a recipient of the 2014 John Scott Award.

Stephen Hubbell (University of California, Los Angeles) received a Scientific Achievement Award from the International Union of Forest Research Organizations.

Thomas Hughes (University of Texas at Austin) received the 2014 Computational Mechanics Award from the Japanese Association for Computational Mechanics.

Tony Hunter (Salk Institute for Biological Studies) was awarded the 2014 Royal Medal for Biological Sciences.

Shirley Ann Jackson (Rensselaer Polytechnic Institute) was named to the 2014 STEM Leadership Hall of Fame.

Gerald F. Joyce (Genomics Institute of the Novartis Research Foundation; Scripps Research Institute) was elected to the Institute of Medicine of the National Academies.

Marc Kamionkowski (Johns Hopkins University) was named a 2014 Simons Investigator in Theoretical Physics by the Simons Foundation.

Paul Kennedy (Yale University) was awarded the Hattendorf Prize for Distinguished Original Research in Maritime History from the U.S. Naval War College.

Richard Kenyon (Brown University) was named a 2014 Simons Investigator in Mathematics by the Simons Foundation.

Robert O. Keohane (Princeton University) received the 2014 James Madison Award from the American Political Science Association.

Susan Kidwell (University of Chicago) was awarded the 2015 Mary Clark Thompson Medal from the National Academy of Sciences.

Mary-Claire King (University of Washington) received the 2014 Lasker-Koshland Special Achievement Award. She was also honored with the Seventh Annual American Association for Cancer Research Distinguished Lectureship in Breast Cancer Research.

Leonard Kleinrock (University of California, Los Angeles) is the recipient of the 2015 BBVA Foundation Frontiers of Knowledge Award in Information and Communication Technologies.

Jennifer A. Lewis (Harvard University) has been named a 2014 Global Thinker by *Foreign Policy* magazine.

Timothy Ley (Washington University in St. Louis) received the 2014 Distinguished Scientist Award from the Association of American Cancer Institutes.

Charles M. Lieber (Harvard University) received the inaugural Tsinghua University Press-Springer Nano Research Award.

Susan Lindquist (Whitehead Institute for Biomedical Research) is the recipient of the 2014 Vanderbilt Prize in Biomedical Science.

Stephen J. Lippard (Massachusetts Institute of Technology) received the 2015 Benjamin Franklin Medal in Chemistry.

Jane Lubchenco (Oregon State University) has been selected as a U.S. Science Envoy.

Alexander Lubotzky (Hebrew University of Jerusalem) has been named to the Israel Academy of Sciences and Humanities.

Kristin Luker (University of California, Berkeley) was awarded a Wilbur Cross Medal from the Yale Graduate School of Arts and Sciences.

Arun Majumdar (Stanford University) has been selected as a U.S. Science Envoy.

Susan Mann (University of California, Davis) received an Award for Scholarly Distinction from the American Historical Association.

Charles F. Manski (Northwestern University) was elected a Corresponding Fellow of the British Academy.

Margaret H. Marshall (Harvard Law School; Choate Hall & Stewart LLP) received the American Bar Association's 2014 Thurgood Marshall Award. She also received the 2014 We Are Boston Leadership Award.

Steve Martin (Beverly Hills, California) received a Lifetime Achievement Award from the American Film Institute.

Claire Max (University of California, Santa Cruz) is the recipient of the 2015 Joseph Weber Award for Astronomical Instrumentation of the American Astronomical Society.

James McGaugh (University of California, Irvine) received the 2015 University of Louisville Grawemeyer Award for Psychology.

Fred McLafferty (Cornell University) received the Nakanishi Prize from the American Chemical Society.

Ajay K. Mehrotra (Indiana University; Academy Visiting Scholar, 2006–2007) received the 2014 Book Award from the Society for U.S. Intellectual History for *Making the Modern American Fiscal State: Law, Politics, and the Rise of Progressive Taxation, 1877–1929*.

Edward Wilson Merrill (Massachusetts Institute of Technology) was elected to the Institute of Medicine of the National Academies.

Charles Misner (University of Maryland) was awarded the Einstein Medal by the Albert Einstein Society. He shares the prize with **Stanley Deser** (Brandeis University).

Nancy Moran (University of Texas at Austin) was elected a Fellow of the Entomological Society of America.

Shree Nayar (Columbia University) has been elected a Fellow of the National Academy of Inventors.

Elissa L. Newport (Georgetown University) received the 2015 Benjamin Franklin Medal in Computer and Cognitive Sciences.

Stephen G. Nichols (Johns Hopkins University) is the recipient of a Humboldt Research Award from the Alexander von Humboldt Foundation.

Joseph S. Nye (Harvard Kennedy School) was awarded the Order of the Rising Sun, Gold and Silver Star, by the Japanese government.

Bert O'Malley (Baylor College of Medicine) is the recipient of the Outstanding Innovation in Science Award from the Endocrine Society.

Stanley Osher (University of California, Los Angeles) was awarded the Carl Friedrich Gauss Prize.

John Parrish (Center for Integration of Medicine and Innovative Technology) received the 2014 Distinguished Service Award from the U.S. Department of Defense.

Saul Perlmutter (University of California, Berkeley) was awarded a 2015 Breakthrough Prize in Fundamental Physics.

Edmund Phelps (Columbia University) was awarded a Wilbur Cross Medal from the Yale Graduate School of Arts and Sciences.

Robert Reich (University of California, Berkeley) was awarded the Dean's Medal from the Heller School for Social Policy and Management at Brandeis University.

James R. Rice (Harvard University) was awarded the Theodore von Karman Medal of the American Society of Civil Engineers.

Geraldine Richmond (University of Oregon) has been selected as a U.S. Science Envoy.

Adam Riess (Johns Hopkins University; Space Telescope Science Institute) was awarded a 2015 Breakthrough Prize in Fundamental Physics.

Mary K. Rothbart (University of Oregon) received the 2014 Block Award from the Society of Personality and Social Psychology.

Gary Ruvkun (Harvard Medical School; Massachusetts General Hospital) was awarded a 2015 Breakthrough Prize in Life Sciences.

Scott D. Sagan (Stanford University) is the recipient of the 2015 William and Katherine Estes Award from the National Academy of Sciences.

Randy W. Schekman (University of California, Berkeley) was elected to the Institute of Medicine of the National Academies.

Stuart Schreiber (Broad Institute of Harvard and MIT) received the New York Academy of Medicine's 2014 Academy Medal for Distinguished Contributions in Biomedical Science.

Alan Shapiro (University of North Carolina at Chapel Hill) received the North Carolina Award from the state of North Carolina.

Charles Simonyi (Intentional Software Corporation) has been named a Stanford Engineering Hero.

Timothy Springer (Harvard Medical School) was awarded the 2014 Henry M. Stratton Medal by the American Society of Hematology.

Katepalli R. Sreenivasan (New York University) was elected a Foreign Fellow of the Indian National Academy of Engineering.

Deepak Srivastava (Gladstone Institute of Cardiovascular Disease; University of California, San Francisco) was elected to the Institute of Medicine of the National Academies.

Dennis Parnell Sullivan (City University of New York) was awarded a 2014 Balzan Prize.

Joseph Takahashi (University of Texas Southwestern Medical Center) was elected to the Institute of Medicine of the National Academies.

Terence Tao (University of California, Los Angeles) was awarded the 2014 Royal Medal for Physical Sciences.

Richard Tapia (Rice University) received the 2014 Mayor's Hispanic Heritage Lifetime Achievement Award from the city of Houston.

Eva Tardos (Cornell University) has been selected by the International Council for Industrial and Applied Mathematics to deliver the Olga Taussky-Todd Lecture.

John Meurig Thomas (University of Cambridge) has been elected a Foreign Fellow of the Royal Swedish Academy of Sciences. He has also been awarded the Blaise Pascal Medal for Materials Science by the European Academy of Sciences.

G. David Tilman (University of Minnesota) was awarded a 2014 Balzan Prize.

Laurence H. Tribe (Harvard Law School) received the 2014 YLD Fellows Award from the Young Lawyers Division of the American Bar Association.

Ronald David Vale (University of California, San Francisco) was elected to the Institute of Medicine of the National Academies.

Peter Walter (University of California, San Francisco) was awarded a 2014 Albert Lasker Basic Medical Research Award. He is also the recipient of the Vilcek Prize in Biomedical Science.

Susan R. Wessler (University of California, Riverside) has been awarded the McClintock Prize for Plant Genetics and Genome Studies.

Mary Jane West-Eberhard (Smithsonian Tropical Research Institute) was awarded the Hamilton Prize from the International Union for the Study of Social Insects.

John A. Whitehead (Woods Hole Oceanographic Institution) is the recipient of the 2014 Maurice Ewing Medal from the American Geophysical Union.

David Wilkins (Harvard Law School) was named a Corresponding Academic for the United States of America by the Board of the Reial Acadèmia de Doctors and is the recipient of the APTISSIMI Award for Academic Excellence, given by the ESADE Law School.

Rachel Wilson (Harvard Medical School) received the 2014 Blavatnik Award for Young Scientists.

Christoph Wolff (Harvard University) received the AGO President's Award from the American Guild of Organists.

Eli Yablonovitch (University of California, Berkeley) received the 2014 Rank Prize, given by the Rank Foundation.

Janet L. Yellen (U.S. Federal Reserve System) is the recipient of the Elizabeth Blackwell Award from Hobart and William Smith Colleges.

Shoucheng Zhang (Stanford University) received the 2015 Benjamin Franklin Medal in Physics.

New Appointments

Danielle S. Allen (Institute for Advanced Study) has been appointed Director of the Edmond J. Safra Center for Ethics at Harvard University.

David Altshuler (Broad Institute; Harvard Medical School) has joined Vertex Pharmaceuticals as Executive Vice President of Global Research and Chief Scientific Officer.

Dennis A. Ausiello (Massachusetts General Hospital; Harvard Medical School) has been appointed to the Board of Directors of Blend Therapeutics, Inc.

Lawrence S. Bacow (Harvard Kennedy School) has been appointed to the Board of Directors of Henry Schein, Inc.

Bonnie Bassler (Princeton University) has been elected to the Board of Trustees of the Alfred P. Sloan Foundation.

Jeffrey Bluestone (University of California, San Francisco) was appointed Scientific Advisor to Juno Therapeutics.

Herbert Boyer (University of California, San Francisco) was appointed to the Board of Directors of Cypher Genomics, Inc.

Randel E. Bryant (Carnegie Mellon University) has been named Assistant Director for Information Technology Research and Development in the Office of Science and Technology Policy, Executive Office of the President.

Richard Carlson (Carnegie Institution for Science) has been named Director of the Department of Terrestrial Magnetism at the Carnegie Institution for Science.

Ashton B. Carter (formerly U.S. Department of Defense) has been appointed Senior Executive at the Markle Foundation.

Gerhard Casper (Stanford University) has been named President of the American Academy in Berlin.

Constance Cepko (Harvard Medical School) has been named to the Scientific Advisory Board of Advanced Cell Technology, Inc.

Francisco Cigarroa (University of Texas Health Science Center) has been elected to the Board of Trustees of the Ford Foundation.

Mary Sue Coleman (University of Michigan) was appointed to the Mayo Clinic Board of Trustees.

George Daley (Boston Children's Hospital; Harvard Medical School) has been named to the Scientific Advisory Board of Advanced Cell Technology, Inc.

James E. Darnell, Jr. (Rockefeller University) has been named to the Scientific Advisory Board of Agilis Biotherapeutics, LLC.

Brian Druker (Oregon Health & Science University) has been appointed to the External Advisory Board of the Huntsman Cancer Institute at the University of Utah.

Joseph J. Fins (Weill Cornell Medical College) has been appointed to serve on the New York State Department of Health Palliative Care Education and Training Council.

W. Kent Fuchs (Cornell University) has been named President of the University of Florida.

Alan D. Grossman (Massachusetts Institute of Technology) has been named Head of the Department of Biology at the Massachusetts Institute of Technology.

Naomi Halas (Rice University) has been named Director of the Richard E. Smalley Institute for Nanoscale Science and Technology at Rice University.

Lars Peter Hansen (University of Chicago) has been appointed Cochair of the Becker Friedman Institute for Research in Economics.

Jon Kleinberg (Cornell University) has been named interim Dean of the Faculty of Computing and Information Science at Cornell University.

Robert Langer (Massachusetts Institute of Technology) has been named Chair of the Scientific Advisory Board of Advanced Cell Technology, Inc.

Jeffrey M. Leiden (Vertex Pharmaceuticals) has been elected to the Board of Directors of Quest Diagnostics.

Jane Lubchenco (Oregon State University) has been appointed to the Board of Trustees of the National Geographic Society.

Pamela Matson (Stanford University) has been appointed to the Board of the Foundation for Food and Agriculture Research.

Claire Max (University of California, Santa Cruz) has been appointed Interim Director of UC Observatories.

Silvio Micali (Massachusetts Institute of Technology) has joined Monument Capital Group Holdings as a Scientific Advisor.

Mark A. Ratner (Northwestern University) has been named Interim Dean of the Weinberg College of Arts and Sciences at Northwestern University.

L. Rafael Reif (Massachusetts Institute of Technology) has been elected to the Board of Directors of Alcoa.

Richard H. Scheller (Genentech) has been named to the Board of Trustees of the California Institute of Technology.

Matthew P. Scott (Stanford University School of Medicine) has been appointed President of the Carnegie Institution for Science.

John L. Thornton (Brookings Institution) has been named Chairman of PineBridge Investments.

A. Eugene Washington (University of California, Los Angeles) has been named Chancellor for Health Affairs and President and Chief Executive Officer of the Duke University Health System.

Huntington Willard (Duke University) has been appointed President and Director of the Marine Biological Laboratory in Woods Hole, Massachusetts.

Ellen Williams (BP p.l.c.; University of Maryland) has been confirmed by the U.S. Senate as the Director of the Advanced Research Projects Agency-Energy (ARPA-E).

Select Publications

Poetry

Samuel Barondes (University of California, San Francisco). *Before I Sleep: Poems For Children Who Think*. North Street Steps Press, May 2014

Paul Muldoon (Princeton University). *One Thousand Things Worth Knowing: Poems*. Farrar, Straus and Giroux, January 2015

Gerald Stern (Drew University). *Divine Nothingness: Poems*. W.W. Norton, November 2014

Fiction

Martin Amis (Brooklyn, New York). *The Zone of Interest*. Knopf, September 2014

Jane Smiley (New York, New York). *Early Warning*. Knopf, May 2015

Nonfiction

Peter Ackroyd (*London Times*). *Rebellion: The History of England from James I to the Glorious Revolution*. St. Martin's/Thomas Dunne Books, November 2014

Bernard Bailyn (Harvard University). *Sometimes an Art: Nine Essays on History*. Knopf, January 2015

Claude Fischer (University of California, Berkeley). *Lurching Toward Happiness in America*. MIT Press, November 2014

Stanley Fish (Florida International University). *Versions of Academic Freedom: From Professionalism to Revolution*. University of Chicago Press, October 2014

Michael S. Gazzaniga (University of California, Santa Barbara). *Tales from Both Sides of the Brain: A Life in Neuroscience*. Ecco, February 2015

Roberto González Echevarría (Yale University). *Cervantes' "Don Quixote."* Yale University Press, April 2015

Donald Hall (Wilmot, New Hampshire). *Essays After Eighty*. Houghton Mifflin Harcourt, December 2014

Herbie Hancock (Los Angeles, California). *Possibilities*. Viking, October 2014

David N. Keightley (University of California, Berkeley). *These Bones Shall Rise Again*. State University of New York Press, July 2014

Thomas Forrest Kelly (Harvard University). *Capturing Music: The Story of Notation*. W.W. Norton, November 2014

William Kentridge (Johannesburg, South Africa). *Six Drawing Lessons*. Harvard University Press, September 2014

David Konstan (New York University; Brown University). *Beauty: The Fortunes of an Ancient Greek Idea*. Oxford University Press, January 2015

Laurence J. Kotlikoff (Boston University), **Philip Moeller** (Boston College), and **Paul Solman** (Yale University). *Get What's Yours: The Secrets to Maxing Out Your Social Security*. Simon & Schuster, February 2015

Hermione Lee (University of Oxford). *Penelope Fitzgerald: A Life*. Knopf, November 2014

Saul Levmore (University of Chicago Law School) and **Martha C. Nussbaum** (University of Chicago Law School), eds. *American Guy: Masculinity in American Law and Literature*. Oxford University Press, September 2014

Kenneth M. Ludmerer (Washington University School of Medicine). *Let Me Heal: The Opportunity to Preserve Excellence in American Medicine*. Oxford University Press, October 2014

Douglas S. Massey (Princeton University) and **Stefanie Brodmann** (World Bank). *Spheres of Influence: The Social Ecology of Racial and Class Inequality*. Russell Sage Foundation, August 2014

Martha C. Nussbaum (University of Chicago Law School) and **Saul Levmore** (University of Chicago Law School), eds. *American Guy: Masculinity in American Law and Literature*. Oxford University Press, September 2014

Francis Oakley (Williams College). *The Watershed of Modern Politics*. Yale University Press, June 2015

Gustavo Pérez Firmat (Columbia University). *A Cuban in Mayberry: Looking Back at America's Hometown*. University of Texas Press, October 2014

Judith Rodin (Rockefeller Foundation). *The Resilience Dividend: Being Strong in a World Where Things Go Wrong*. PublicAffairs, November 2014

Neil L. Rudenstine (ARTstor). *Ideas of Order: A Close Reading of Shakespeare's Sonnets*. Farrar, Straus and Giroux, November 2014

Jeffrey D. Sachs (Columbia University). *The Age of Sustainable Development*. Columbia University Press, March 2015

Jonathan D. Sarna (Brandeis University) and **Benjamin Shapell** (Shapell Manuscript Foundation). *Lincoln and the Jews: A History*. St Martin's/Thomas Dunne Books, March 2015

Frederick A.O. Schwarz Jr. (Brennan Center for Justice, New York University School of Law). *Democracy in the Dark: The Seduction of Government Secrecy*. New Press, April 2015

Laurence Senelick (Tufts University). *Stanislavsky: A Life in Letters*. Routledge, October 2014; *Soviet Theater: A Documentary History* (with Sergei Ostrovsky). Yale University Press, May 2015; translation of *The Madwoman of Chailot* by Jean Giraudoux. Broadway Play Publishing, May 2015

Laurence Steinberg (Temple University). *Age of Opportunity: Lessons from the New Science of Adolescence*. Houghton Mifflin Harcourt, September 2014

Michael Walzer (Institute of Advanced Study). *The Paradox of Liberation: Secular Revolutions and Religious Counterrevolutions*. Yale University Press, March 2015

Cornel West (Princeton University) with **Christa Buschendorf** (Goethe-Universität Frankfurt am Main). *Black Prophetic Fire*. Beacon Press, October 2014

Garry Wills (Northwestern University). *The Future of the Catholic Church with Pope Francis*. Viking, March 2015

Albums

Ralph Stanley (Coeburn, Virginia). *Man of Constant Sorrow: Ralph Stanley & Friends*, released January 2015

We invite all Fellows and Foreign Honorary Members to send notices about their recent and forthcoming publications, scientific findings, exhibitions and performances, and honors and prizes to bulletin@amacad.org. ■

In Memoriam: Robert W. Fri (1935–2014)

Elected to the Academy in 2010



It is with profound sadness that I note the death on October 10, 2014, of Robert W. Fri, my cochair on the Academy’s Alternative Energy Future project. Bob was an influential expert on energy policy and a renowned leader in government and nonprofit circles. His extraordinary vision, intelligence, and strategic skills made him the ideal person to lead public policy studies, which he did with remarkable success for the American Academy, the Department of Energy, and the National Research Council, among other organizations.

Throughout Bob’s distinguished career he demonstrated an exceptional ability to distill the most salient conclusions from wide-ranging conversations. On more than one occasion, at the end of a long workshop when most of the participants in the room were still sorting quizzically through their notes, Bob would break the impasse by saying, “Here are what I take to be the four main points from this meeting. . . .” He would then go on to propose, in extraordinarily clear and concise terms, what the next steps should be.

His popularity as a leader owed equally to his trademark folksy manner and dry wit. I recall his response to an unusually long email that I composed on a cross-country flight home to Los Angeles, with a large number of comments and suggestions on a proposed workshop agenda. His reply was simply, “All good suggestions. I’m glad you had a long flight.”

Later, upon learning of my election to the Academy, Bob described the Academy’s annual Induction Ceremony as a “hoot” and encouraged me to attend, although he did warn that “there are some of us who question whether bagpipes should ever be played indoors.”

Born in Kansas City and educated at Rice University and Harvard Business School, Bob spent several years at McKinsey and Company before moving into public service in 1971. As the first deputy administrator both of the U.S. Environmental Protection Agency and the Energy Research and Development Administration (ERDA, the predecessor to the U.S. Department of Energy), Bob played a major role in setting up the organizational structure of these agencies. He later served as president of Resources for the Future and of the National Museum of Natural History, in both cases guiding these organizations through a tumultuous time of transition.

I first met Bob at ERDA in 1975, when he was the Deputy Administrator and I was responsible for developing and implementing energy efficiency R&D programs in the buildings and industry sectors. Interest in government energy programs had developed as a result of the 1973 oil embargo and there was pent-up demand among industries, academics, and national laboratories to help address the end-use sector. My program, however, did not have a large budget – less than \$10 million – and it lacked the long history of the rest of ERDA, which had been part of the Atomic Energy Commission. Bob was instrumental in helping me to establish a portfolio approach to identify the most important areas on which to focus and to select the best proposals from over six hundred unsolicited applications for limited funds.

Bob also supported the hiring of social scientists for the ERDA buildings program, and they were able to conduct rudimentary marketing campaigns, “feedback” programs for consumers, and other studies that helped guide our technology deployment efforts. Such nontraditional R&D programs and approaches were supported by Bob throughout his career, and laid the groundwork for today’s resurgent interest in how consumers’ beliefs and behaviors influence their energy choices.

Bob was truly a wise mentor, always able to enlist the best people and empower them. This led to the remarkable success in the development of energy efficient technologies for lighting, windows, refrigerators, and more, and their commercialization by the private sector.

Bob was an early proponent of the importance of determining and measuring the outcomes of government programs and policies. I was fortunate to serve on several National Research Council com-

mittees that he chaired. Many of these studies developed methods to determine the retrospective and prospective benefits of DOE's energy R&D programs. A 2001 study, *Energy Research at DOE: Was It Worth It? Energy Efficiency and Fossil Energy Research 1978 to 2000*, is still quoted by the U.S. Secretary of Energy and serves as a model used to review other government programs.

In 2010, Bob was an active member of the working group for the President's Council of Advisors on Science and Technology study, *Accelerating the Pace of Change in Energy Technologies Through an Integrated Federal Energy Policy*. His key contributions regarding the concept of innovation in the energy area led to one of the study's major recommendations that DOE and the National Science Foundation establish a joint interdisciplinary program with social scientists to understand the social and regulatory barriers to the adoption of new energy technologies. This recommendation guided the establishment of the Academy's Alternative Energy Future project, which Bob directed from its inception in 2010, and which I had the privilege to chair with him.

Bob was a remarkable leader, a visionary on energy policy, and a truly wonderful and humble person. He had a wide and diverse circle of friends and colleagues. His humor and modesty were captured at his memorial service: Having selected all of the music and readings, Bob decreed that no one should stand to speak about him or his career. He told the pastor that should anyone be tempted to do so, he would haunt them for the rest of their life.

I am grateful for Bob's wise counsel and for his steadfast commitment to progressive environmental and energy policy. He will be sorely missed. ■

Maxine L. Savitz

*Cochair, Alternative Energy Future project, American Academy;
General Manager of Technology Partnerships, Honeywell, Inc., ret. ;
Vice Chair, President's Council of Advisors on Science and Technology*

Remembrance

*It is with sadness that the Academy notes the passing of the following Members.**

Don Lynn Anderson – December 2, 2014; elected in 1972

Andrew A. Benson – January 16, 2015; elected in 1981

Sacvan Bercovitch – December 9, 2014; elected in 1986

Robert A. Berner – January 10, 2015; elected in 1991

Edward William Brooke – January 3, 2015; elected in 1965

Stirling Auchincloss Colgate – December 1, 2013;
elected in 1978

Philip Ernest Converse – December 30, 2014; elected in 1969

Carl Neumann Degler – December 27, 2014; elected in 1973

Carl Djerassi – January 30, 2015; elected in 1968

Eugene B. Dynkin – November 14, 2014; elected in 1978

Herman N. Eisen – November 2, 2014; elected in 1965

Val Logsdon Fitch – February 5, 2015; elected in 1966

Rose E. Frisch – January 30, 2015; elected in 1997

William P. Gerberding – December 27, 2014; elected in 2009

Marvin Leonard Goldberger – November 26, 2014;
elected in 1965

Alexander Grothendieck – November 13, 2014; elected in 1965

Martin Charles Gutzwiller – March 3, 2014; elected in 1993

Henry Harris – October 31, 2014; elected in 1970

Sanford Harold Kadish – September 5, 2014; elected in 1975

Galway Kinnell – October 28, 2014; elected in 1997

James Lloyd Kinsey – December 20, 2014; elected in 1989

Edward J. Kramer – December 27, 2014; elected in 2012

Harden Marsden McConnell – October 8, 2014;
elected in 1968

Anna Elbina Morpurgo-Davies – September 27, 2014;
elected in 1986

Vernon Benjamin Mountcastle – January 11, 2015;
elected in 1965

Guy W. Nichols – June 18, 2014; elected in 1990

Mike Nichols – November 19, 2014; elected in 1999

Robert Pirie – January 15, 2015; elected in 1985

Lester James Reed – January 14, 2015; elected in 1981

Melford Elliot Spiro – October 18, 2014; elected in 1975

Donald Frederick Steiner – November 11, 2014;
elected in 1972

Robert Stone – January 10, 2015; elected in 1994

Mark Strand – November 29, 2014; elected in 1995

Patrick Suppes – November 17, 2014; elected in 1968

Charles Hard Townes – January 27, 2015; elected in 1957

Bruce Wallace – January 15, 2015; elected in 1971

John Cunningham Whitehead – February 7, 2015;
elected in 1988

Marvin Zelen – November 15, 2014; elected in 1991

E-an Zen – March 29, 2014; elected in 1982

**Notice received from October 25, 2014, to February 12, 2015*

AMERICAN ACADEMY
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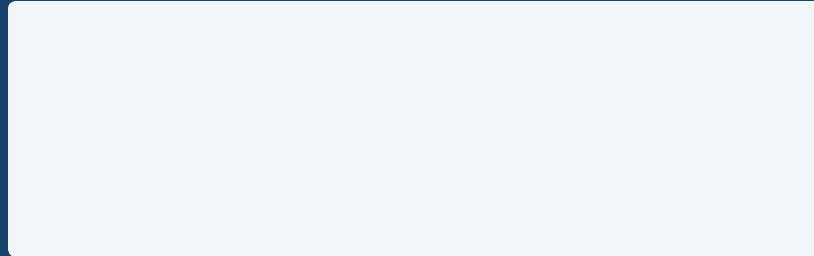
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