



AMERICAN ACADEMY OF ARTS & SCIENCES

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# Bulletin

WINTER 2016  
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## Induction Ceremony 2015:

*Class Speakers: Phil S. Baran; Sally Haslanger;  
Darren Walker; Patricia Smith Churchland; and  
Roland G. Fryer, Jr.*



## Exploding Stars and the Accelerating Universe

*Alexei V. Filippenko*

**ALSO:** Academy Presents Scholar-Patriot Award to Morton L. Mandel  
The Evolving Role of Technology in Higher Education – Matthew S. Santirocco, Nicholas Lemann, Kevin Guthrie, and Daphne Koller  
Scientific Advances and Their Impact on Society – Lawrence Goldstein, J. Craig Venter, Lisa Madlensky, and John H. Evans  
Making Justice Accessible – Diane P. Wood, Goodwin Liu, and David S. Tatel  
On the Professions – Theodor Meron, Rolena Adorno, and Joan B. Silk

# Upcoming Events

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## MARCH

### 4th

House of the Academy  
Cambridge, MA

#### Friday Forum

*Symbols from History: What is the Intellectually Honest and Morally Right Way to Deal with Inflammatory Symbols from our Past?*

Featuring: **Daniel R. Coquillette** (Boston College Law School; Harvard Law School)

### 10th

House of the Academy  
Cambridge, MA

#### Lunch and Book Discussion

Featuring: **John Browne** (L1 Energy; formerly BP), author of *Connect: How Companies Succeed by Engaging Radically with Society*

### 15th

House of the Academy  
Cambridge, MA

#### Chamber Series in collaboration with the Cantata Singers

*A Circle of Friends: Chamber Music by Johannes Brahms and Felix and Fanny Mendelssohn*

### 30th

House of the Academy  
Cambridge, MA

*Musical Performance of the Poetry of Walt Whitman and Allen Ginsberg – for Baritone and String Quartet*

Remarks: **Bonnie Costello** (Boston University)  
Performance: **David Kravitz** (baritone) and the **Arneis Quartet**

## APRIL

### 1st

House of the Academy  
Cambridge, MA

#### Friday Forum

Featuring: **Robert A. Weinberg** (Massachusetts Institute of Technology; Whitehead Institute for Biomedical Research)

### 14th

House of the Academy  
Cambridge, MA

*Celebrating the Arts and Sciences: Awarding of the Sarton Poetry Prize and Rumford Prize*

Featuring award recipients: **Vanessa Pravin** (University of California, Merced), **Federico Capasso** (Harvard University), **Alfred Cho** (Alcatel-Lucent's Bell Labs)

## MAY

### 6th

House of the Academy  
Cambridge, MA

#### Friday Forum

Featuring: **Benjamin Friedman** (Harvard University)

### 10th

The Quadrangle Club  
Chicago, IL

*From Biological to Cyber Threats: Opportunities and Challenges in Governing Dual-Use Technology*

Featuring: **James Acton** (Carnegie Endowment for International Peace), **Elisa D. Harris** (Center for International and Security Studies at Maryland), **Robert Rosner** (University of Chicago)

### 16th

Century Association  
New York, NY

*Reception for Academy Members*

### 19th

House of the Academy  
Cambridge, MA

*The Comprehensive Test Ban Treaty at 20*

Featuring: **Rose Gottemoeller** (U.S. Department of State), **Siegfried Hecker** (Stanford University), **Robert Rosner** (University of Chicago), **Lassina Zerbo** (Comprehensive Nuclear Test Ban Treaty Organization)

## From the President



Jonathan F. Fanton

The founders of the American Academy in 1780 aimed to convene leaders in a broad range of fields to give advice to a new nation. As stated in the Academy's Charter of 1780:

...the end and design of the institution of the said Academy is to promote and encourage the knowledge of the antiquities and the natural history of America; to determine the uses to which the various natural productions of the country may be applied; to promote and encourage medical discoveries, mathematical disquisitions, philosophical enquiries and experiments, astronomical, meteorological and geographical observations, and improvements in agriculture, arts, manufactures and commerce; and, in fine, to cultivate every art and science which may tend to advance the interest, honor, dignity, and happiness of a free, independent, and virtuous people.

The Academy has remained faithful to that vision in the 235 years since. Our institution maintains an Archives of meeting proceedings and publications, and all members are invited to visit. It is a moving moment to hold George Washington's letter of acceptance, as well as the letters written by Alexander Hamilton, John Stuart Mill, and other early members of the Academy. I encourage you to visit the Academy's website to learn more about the collections in the Archives.

The Academy has addressed many timely and abiding issues over the centuries, such as the changing nature and needs of higher education and research, the well-being of the humanities in the United States, the emerging challenges of scientific and technological advances, arms control and international security, population and the environment, as well as the welfare of children.

In recent years, more and more members have participated in studies and publications through the Academy. Our work falls into three categories: major commissions have recently examined the state of the humanities and social sciences (*The Heart of the Matter*) and the need for more federal investment in basic research (*Restoring the Foundation*). Two new commissions are described in the pages that follow: the Commission on the Future of Undergraduate Education, chaired by Michael McPherson (President of The Spencer Foundation) and Roger W. Ferguson, Jr. (President and CEO of TIAA-CREF); and a Commission to study the state of language instruction in the country, chaired by Paul LeClerc (Director of Columbia Global Centers, Europe).

A second category of projects, mainly in the international security area, continues the Academy's work on nuclear issues (the Global Nuclear Future Initiative), explores the threats to world order posed by the breakdown of state control and civil wars, and looks at new dilemmas in ethics, technology, and war.

And just last year, the Academy added a third type of work when it created an Exploratory Fund. The goal is to enable members who want to work together to look over the horizon for issues and opportunities that are not well understood, to think about problems in a fresh way, and to search for connections between research and policy that advance the common good. By encouraging these smaller-scale initiatives in a variety of venues, the Academy aims to assist members in pursuing the subjects that concern them the most. For a limited number of projects every year, the Fund will provide up to \$30,000 that can be used in any way that furthers the proposed work, including covering costs associated with the organization of a meeting, symposium, or conference, which could be held here at the Academy or at a member's home university. Academy staff will help organize the meeting and follow up on the recommendations for further work.

## FROM THE PRESIDENT

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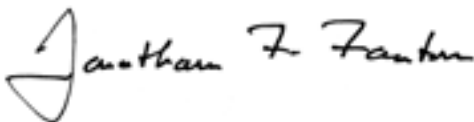
Our first Exploratory Fund meeting on Access to Justice is described on page 7 in this issue of the *Bulletin*. Last November, members John Levi (Chair of the Legal Services Corporation), Martha Minow (Dean of the Harvard Law School), and Lance Liebman (former Dean of the Columbia Law School) brought over fifty jurists, scholars, and legal aid providers to the Academy to consider how to improve the state of legal services for low-income Americans.

Another example of an exploratory project is a conference that took place last December that brought together experts on autism and sign language with the goal of finding ways to apply recent advances in communications among the deaf to problems of communication with and among people with autism. That conference was organized by Mark Aronoff of Stony Brook University, Susan Goldin-Meadow of the University of Chicago, Matthew Lerner of Stony Brook University, and Charles Nelson of Harvard University and Boston Children's Hospital. This particular collaboration was born at a reception following an Induction Ceremony a couple of years ago; it shows how the social interactions we have before and after our formal events can serve a purpose.

Another project will look at the future of jazz. The organizers – Felton Earls of Harvard University and William Damon of Stanford University – believe, as I think many of us do, that jazz is an important art form in bridging cultures, ethnicity, race, and geography. Yet it is facing an uncertain future, and this will be explored in a meeting at the Academy this spring.

Three other projects have just been approved. Arthur Kleinman of Harvard University is going to organize a conversation about the need to bring area studies and global studies closer together. Shari Diamond of Northwestern University and Richard Lambert of the University of Michigan will facilitate a discussion of how scientific expertise and the legal system connect. A meeting on the preservation of scholarship and intellectual legacy in the digital age is being organized by Paula Samuelson and Carla Hesse of the University of California, Berkeley and Robert Darnton of Harvard University.

When we started the Exploratory Fund, we wondered whether members would come forward. To see the level of interest thus far has been wonderful. And we are not done yet. If you have a topic you want to explore with other members, write me a letter. These projects do not involve elaborate, National Science Foundation-type applications. We want to make this quick, easy, and fun.



Jonathan Z. Faust

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# Academy Presents Scholar-Patriot Award to Morton L. Mandel

On January 11, 2016, at a ceremony held at the House of the Academy in Cambridge, Chair of the Board **Don M. Randel** and President **Jonathan F. Fanton** presented the Academy's Scholar-Patriot Award to business leader and entrepreneur **Morton L. Mandel** in recognition of his philanthropy and dedication to public service.



**Jonathan F. Fanton, Morton L. Mandel, and Don M. Randel**

The Scholar-Patriot Award is given for extraordinary contributions of individuals who share the vision of service held by the founders of the American Academy. Previous recipients of the award include cellist and educator Yo-Yo Ma, U.S. Senator Edward M. Kennedy, and William T. Golden, a leading architect of twentieth-century American science policy.

Morton L. Mandel is Chairman and Chief Executive Officer of Parkwood LLC, headquartered in Cleveland, Ohio. With his brothers Jack and Joseph, he founded the Premier Industrial Corporation, which later became one of the world's leading industrial parts and electronic components distributors. Mr. Mandel served as Chairman and Chief Executive Officer of the Corporation from 1957 to 1996.

Mr. Mandel also serves as the Chairman and Chief Executive Officer of the Jack, Joseph, and Morton Mandel Foundation, which funds numerous social leadership initiatives in the United States and Israel. The work of the Foundation is grounded in the belief that exceptional leaders, inspired by powerful ideas, are key to improving society and the lives of people around the world. The Mandel Foundation has identified five areas of engagement that influence its decisions for giving: leadership of nonprofits, management of nonprofit and public sector institutions, Jewish education, humanities in education and the arts, and urban renewal.

Mr. Mandel serves on the Board of Governors of the Hebrew University in Jerusalem and is a Life or Honorary Trustee of Case Western Reserve University, the Cleveland Museum of Art, the United

## Scholar-Patriot Award

January 11, 2016

### Citation

For more than seventy years, your energy, generosity, and dedication to the public good have known no bounds. From humble beginnings, your parents instilled within you the basic values of integrity, respect, honesty, decency and generosity. With your brothers and these core values, you built a thriving global corporation dedicated to the principles of delivering quality products and exceptional service, and the simple yet powerful philosophy: if you find a need, fill it. In your work and your philanthropy, you have developed leaders with passion and intellect. You have modeled the lessons learned early in life to share resources and to be generous relative to your capability, and have inspired generations of leaders in higher education, the Jewish community, and nonprofit organizations to change the world and improve the human condition. You have taught us to dream and to believe dreams can be realized. We are better off because of you.

Business leader, entrepreneur, philanthropist, and dedicated public servant, you are the model of the enlightened, informed, and passionate leader. We honor your outstanding commitment to the community, the nation, and the world.



**Morton L. Mandel**

Way of Cleveland, the Jewish Federation of Cleveland, the Jewish Community Centers of North America, and the Jewish Federations of North America. He is the author of *It's All About Who* (2012). He was elected to the American Academy of Arts and Sciences in 2011.

After the award ceremony, the Garden Room in the House of the Academy was dedicated in honor of Mr. Mandel and named the Morton L. Mandel Garden Room. ■



# Commission on the Future of Undergraduate Education

Higher education continues to be one of the most important avenues of opportunity in American society. But the education landscape is changing rapidly: there are more options for how and when Americans receive some form of higher education. New populations, for whom the traditional four-year degree was once an impossibility, can now pursue undergraduate education in two-year, four-year, for-profit, and online institutions, according to schedules that fit their own lives. And technological advances offer new approaches to student instruction and collaboration. At the same time, rising costs are challenging the affordability of traditional postsecondary degrees.

To address these topics and provide ideas for ensuring that individual Americans receive the education they need to thrive in the twenty-first century, the American Academy has established the Commission on the Future of Undergraduate Education, funded by Carnegie Corporation of New York. Over the next three years, members of this initiative will examine the vast – and expanding – array of learning options available to high-school graduates, including students newly out of high school and older adults returning to school to further their lives and careers. With members drawn from among national leaders in education, business, and government, the Commission will study how well today’s students are served by the existing system and, more important, will seek to identify the challenges and opportunities that higher education will encounter in the decades ahead. Michael S. McPherson (Spencer Foundation) and Roger W. Ferguson, Jr. (TIAA-CREF) are the co-chairs of this project.

At the Commission’s first meeting on November 20, 2015, at the House of the Academy in Cambridge, the members discussed the issues they would like the Commission to address and what challenges they believed the project needs to meet in order to be successful. The conversation led to a series of ambitious and thought-provoking observations: how, for example, can we say who is being served well by higher education without getting more clarity about what a higher education is supposed to accomplish? While there is a great deal of attention paid to the outcomes of college, there is much less public attention to the process of college education itself – how does learning come about for students, and how do educational experiences in and out of the classroom shape those results? Commissioners noted that historically an important purpose of higher education has been to help form good citizens and foster social progress, and in a society like ours that remains deeply divided on fundamental matters including race, economic inequality, and the global phenomenon of climate change, this purpose remains important and must be addressed.



**Nicholas Lemann** (Columbia University Graduate School of Journalism), **Deborah Ball** (University of Michigan School of Education), and **Beverly Tatum** (Spelman College)

Another theme raised at the meeting was that, after the expansion of opportunity brought about by the introduction of federal student aid grants and loans in the 1970s, the ranks of college students expanded to include a significant number of adult students over the age of 24. These adult students consistently make up roughly a third of the undergraduate population. Their education goals and the obstacles in accomplishing them tend to differ substantially from those of recent high-school graduates. In addition, the Commissioners raised issues of cost and affordability.

With these questions and challenges in mind, the Commission is beginning to develop a data-rich portrait of American postsecondary education. This primer will convey the story of the major themes and trends in undergraduate education through the framework of the contemporary student journey into, through, and out of college. Scheduled for release later this year, the primer will serve both as a foundation for the Commission’s larger work and as a valuable resource for a broad public audience. For more information about the Commission on the Future of Undergraduate Education, please visit the Academy’s website. ■

## Commission on Language Learning

Following an enthusiastic reception of the 2013 Humanities Commission Report, the American Academy received a congressional charge to extend the portion relating to language education. This bipartisan charge revealed concerns about the deleterious effects of the current state of the nation's language capability on political, economic, and social prosperity. The congressional letter encouraged a broad examination of the issue, one that addresses concerns about the personal fulfillment of all Americans and the well-being of future generations, in addition to evaluating needs for critical global challenges.

On December 15, 2015, the Language Commission convened its first meeting at the Academy's headquarters in Cambridge, MA, under the leadership of Paul LeClerc. Dr. LeClerc, former president of the New York Public Library, is Director of Columbia Global Centers, Europe and the Networking Chair. Other members of the Commission include prominent linguists and scholars of languages, representatives of the U.S. Departments of State and Defense, experts in language-acquisition technology, corporate and legal experts, and leading advocates from the American Councils for International Education, the Modern Language Association, and the American Council on the Teaching of Foreign Languages.

Academy President Jonathan Fanton opened the meeting by citing an early Academy document from 1781, which demonstrated America's long-standing concerns and commitment to language education. He went on to frame the context of the current meeting in terms of a late-nineteenth-century initiative, namely Henry W. Williams's call "to remove every impediment to a ready intercourse and move forward every facility for the acquisition and distribution of whatever knowledge conduces to the common good." Dr. Fanton asked the Commission to explore what such an enterprise would mean for a global community rich in ideas, but rife with political and linguistic divides.

Initial discussion focused on the findings of five briefing papers. These findings, along with the Commission's ensuing conversation, made it clear that although there are several studies that report on different portions of the language capability issue, no publication to date provides an overarching account of the entire state of the nation's language capabilities. The scope of this data, while impressively detailed, makes it difficult to form an overall picture of America's language needs. In response, the Language Commission decided to form a subcommittee on Research and Data, to collect all research findings into one short but comprehensive document about the teaching of languages in the United States.

The Commission also discussed that domestic and international needs in language training can often raise separate sets of issues. In an international context, America has reasons to emphasize the learning of languages like Arabic, Russian, or even Pashto. It could also follow in the footsteps of nations like Great Britain, which have discussed prioritizing the study of languages affiliated with emerging markets (e.g., Portuguese, Mandarin, Russian, and Hindi). Domestic issues, by contrast, raise concerns about insufficient interpreters within our health and legal systems, numerous indigenous American languages listed as endangered or critically endangered, and a growing body of psychological findings concluding that American children who are not taught in their native languages appear to be more vulnerable to depression and feelings of alienation later in life.

The Language Commission also decided that it cannot overlook the impact of technology in developing modern-day communication. In the age of artificial intelligence, technology will play a greater role in making language learning more accessible and also more integral for the international market. Already, the U.S. Department of State and other organizations use virtual reality as a means to teach critical languages. The Commission will investigate how technology affects language learning, particularly for purposes of international trade and research. ■



**Mark Aronoff** (Stony Brook University), **Diane P. Wood** (U.S. Court of Appeals, Seventh Circuit), **Hunter R. Rawlings III** (Association of American Universities), **Jonathan F. Fanton** (American Academy), **Paul LeClerc** (Columbia Global Centers, Europe), and **Nancy McEldowney** (Foreign Service Institute, U.S. Department of State)



## Exploratory Fund Meeting

# Legal Services for Low-Income Americans

On November 11 and 12, 2015, over 50 Judges and Justices, Chief Justices, legal scholars, and lawyers gathered at the American Academy of Arts and Sciences. Brought together by John Levi, Chairman of the Legal Services Corporation; Martha Minow, Dean of the Harvard Law School; and Lance Liebman, former Dean of the Columbia Law School, the group discussed the nation's failure to provide legal services for low-income Americans. By some estimates, only 20 percent of qualified Americans receive the necessary aid they require as they move through the American justice system. Millions are left unaided and unable to negotiate a complicated legal system on their own. The participants at the Academy symposium assessed the magnitude of the issue, discussed strategies for solving the problem, and generated further ideas about enhancing citizens' access to justice.



**Left to Right: Maureen O'Connor (Chief Justice, Supreme Court of the State of Ohio), Nathan Hecht (Chief Justice, Texas Supreme Court), Mark Recktenwald (Chief Justice, Supreme Court of Hawaii), Martha Minow (Dean, Harvard Law School), Jonathan Lippman (former Chief Judge, State of New York), and Ralph Gants (Chief Justice, Massachusetts Supreme Judicial Court)**

President Jonathan Fanton opened the meeting and highlighted the Academy's long-standing interest in poverty and the legal field. He quoted an early Academy member, Benjamin Dearborn, who, in a proposal to John Adams to organize a committee to aid widows and orphans, said, "Of all the arts or sciences, none is more grateful than the art of reducing the Evils of Life." Reducing those evils has been a pillar of the Academy's work ever since.

John Levi, in his opening remarks, urged the group to recognize just how serious the issue in the United States truly is and to act on the obligation to bring justice to all. A series of panel discussions followed, on topics ranging from fees and the difficulty of navigating the court system to the role of corporations in providing pro bono representation and the use of technology in the legal profession. Martha Minow, James Sandman (President of the Legal Services Corporation), Lora Livingston (Judge of the 261st Civil Dis-

trict Court in Austin, Texas), Lisa Foster (Director of the Office for Access to Justice, Department of Justice), and David F. Levi (Dean of Duke University School of Law) moderated the discussions.

To bring this issue to a wider audience, at the end of the first day of the symposium, the Academy hosted a program on Making Justice Accessible, which served as the Inaugural Distinguished Morton L. Mandel Annual Public Lecture. Diane P. Wood (Chief Judge of the United States Court of Appeals for the Seventh Circuit), Goodwin Liu (Associate Justice of the California Supreme Court), and David S. Tatel (Judge on the United States Court of Appeals for the District of Columbia Circuit) discussed issues of access to the justice system (see pages 49–53 in this issue of the *Bulletin* for their presentations).

John Levi, Martha Minow, and Lance Liebman are discussing possible next steps and ways the Academy can contribute to this work. ■

## Exploratory Fund Meeting

# Consortium on Autism and Sign Language

The Consortium on Autism and Sign Language (CASL) gathered at the American Academy of Arts and Sciences on December 12 and 13, 2015, for a conference sponsored by the Academy's Exploratory Fund. CASL gathered scholars from diverse fields and individuals from stakeholder communities to gain an understanding of the nature of communication in populations for whom it may otherwise be difficult. The meeting participants advanced novel hypotheses about the emergence of communication in autism by leveraging methods and insights from sign language research. The participants included Academy Fellows **Mark Aronoff** (Stony Brook University), **Susan Goldin-Meadow** (University of Chicago), **Paul Harris** (Harvard Graduate School of Education), **Nancy Kanwisher** (Massachusetts Institute of Technology), **Charles Nelson** (Harvard Medical School), **David Perlmutter** (University of California, San Diego), and **Mrikanga Sur** (Massachusetts Institute of Technology).

The topics discussed in the individual presentations and roundtable panels included whether the precision hypothesis – the preference for precision over efficacy of communication in autism – is valid across developmental levels of autism; and whether precision in autistic communication may be as much culturally as developmentally conditioned. Divergent goals in communication may explain precision differences: an individual with autism may aim to be precise while typically developing individuals might value using other aspects of perspective to achieve simpler communication. Cultural differences framed the discussions of social-developmental trajectories in autism. Stereotypical characteristics of autism, such as avoidance of eye contact, which is seen as abnormal in most westernized cultures, is common in other cultures. The discussions provided a new framework for considering the potential uniqueness of social-developmental trajectories in autism on a global scale.

The conference achieved its goals by allowing dialogue among individuals from multiple disciplines to better inform each field's research: by looking at language and communication from different angles the participants gained a better understanding of communication in deaf and autistic individuals. The conference also provided a venue for members of autistic and deaf communities to be active contributors to the dialogue. It was made clear by both scholars and individuals with autism that the voices of the communities being studied need to be heard. A series of research questions developed during the meeting will inform the Consortium's next conference. ■

The Exploratory Fund was created to respond to ideas from Academy members who want to work together to discuss ideas and opportunities not well understood. In the coming months, the Academy will convene Exploratory Fund meetings on topics such as the preservation of intellectual legacies, the relationship between area and global studies, integrating scientific expertise into the legal system, and the future of jazz. Please contact the Academy if you have questions about the Exploratory Fund.

# The Academy at Work: Projects and Studies

On October 10, 2015, as part of the Academy's 2015 Induction weekend program, new members were briefed on the Academy's research projects and studies. The speakers, who play an active role in the projects, highlighted the studies' current activities and the many opportunities for new members to participate. The presentations focused on projects in the Humanities and Education; Global Security and International Affairs; and Science, Engineering, and Technology. The briefing also included presentations on Exploratory Projects and projects under consideration. The following is an edited version of the speakers' remarks.

## Humanities and Education

### *Commission on Language Learning*



#### **Paul LeClerc**

*Paul LeClerc is the Director of Columbia Global Centers, Europe and the Networking Chair. He was elected a Fellow of the American Academy in 2001 and serves as Chair of the Academy's Commission on Language Learning.*

My favorite family story about language learning has to do with a trip my wife and I took with our son, Adam, when he was two years old. We were driving to his grandparents' house and passed a billboard with

### **How does language learning influence economic growth, cultural diplomacy, the productivity of future generations, and the fulfillment of all Americans?**

advertisements for Delta Air Lines flights to Florida. The symbol used to express the state of Florida was two gigantic flamingos. Judith said to Adam in the back seat, "Adam, look at those great big birds. Those are called flamingos. Can you say flamingo?" And he said, "Not yet."

We are now in the process of thinking through just what ought to be the content of the Academy's engagement in a new Commission on Language Learning in the United States. This commission, like the Academy's landmark Commission on the Humanities, was formed in response to an explicit request by bipartisan groups within the U.S. House and Senate that we undertake a study of the nation's language education needs.

Specifically, the Academy was asked by members of Congress to provide answers to the following questions. First, how does language learning influence economic growth, cultural diplomacy, the productivity of future generations, and the fulfillment of all Americans? Second, what actions should the nation take to ensure excellence in all languages,

excellence in international education and research, and the effective use of current and future supplementary resources to advance language attainment? Any one of these mandates in and of itself would be the cause of an enormous amount of concentration and hard work on the part of any commission.

But before we get deeply into this work, the commission will have to resolve one important issue: the question of the acquisition of English language skills. My sense is that what Congress is asking us to do is to look at the acquisition of non-English language skills, which is certainly important in today's increasingly globalized world context, as well as in the context of the gross inequalities that exist within our society and other societies as well.

But many native speakers of English in the United States, of all ages, lack competencies in one or more of the four language skills: speaking, reading, writing, and understanding. The reports that come out on a regular basis about the performance of school children on standardized tests are

all you need to know that English language skills are terribly important to the future welfare of those children and indeed of the nation. So the extent to which we include English in our study is a question we will be discussing intensely at our first meeting.

We also need to keep in mind the increasing dominance of English as a world language. That it is already the language of business around the world helps to explain, for example, the extraordinary sum of mon-

and the leaders of the Modern Language Association, the American Council for the Teaching of Foreign Languages, and other organizations that have a direct interest in the commission's work. Also joining us are distinguished scholars in fields such as linguistics, modern and ancient languages, technology, and law, as well as the chancellor of UC Berkeley, an official from the Department of State, a former ambassador to Afghanistan, and so on.

### **What actions should the nation take to ensure excellence in all languages, excellence in international education and research, and the effective use of current and future supplementary resources to advance language attainment?**

ey recently paid for *The Financial Times* (a significant multiple of what Jeff Bezos paid for *The Washington Post* a couple of years ago), as well as the assumption on the part of many Americans that as long as you can speak English and get along in English you don't need to learn a non-English language.

English may well be, as one of my Academy colleagues says, the solvent language of the world, but I do not agree with the notion that if you do well in English you can get by anywhere in the world. And the attitude we face here in the United States is perhaps even worse than that. Consider the beating John Kerry took as a presidential candidate because he could speak fluent French, which was seen as effete and a negative.

The commission's first task, therefore, will be to clarify our mandate and agree to the importance of considering all aspects of language education and language learning that are related to the congressional mandate or that we choose to add to that mandate. The commission includes members of the original Humanities Commission

In addition, a superb series of briefing papers has been commissioned by John Tessitore, who supports the work of the commission. The topics include America's languages (promises and challenges and an overview); language and economic growth; language, cultural diplomacy, and global security; language and productivity for all Americans; and language and the happiness and fulfillment of individual Americans. If you are interested in assisting the commission in its work or would like to propose experts for the commission to consider, we would love to hear from you.

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## *The Lincoln Project: Excellence and Access in Public Higher Education*



### Mary Sue Coleman

*Mary Sue Coleman is President Emerita of the University of Michigan and President-Elect of the Association of American Universities. She was elected a Fellow of the American Academy in 2001 and serves as Cochair of the Lincoln Project.*

Since the Lincoln Project started a bit more than two years ago, we have issued two of our five contemplated publications. The first to be published addresses why public research universities matter. The second is now online and will soon be out in paper form; it explores changes in state funding for public research universities. We anticipate a third paper about university finances, a topic that is rather opaque to the general public. The fourth publication will discuss what impact public research universities have had, and our final publication, which we hope will come out in the middle of the election season, will offer recommendations for what we might do to address what we believe is a crisis in public research universities.

The Lincoln Project honors President Abraham Lincoln and his role in signing the 1862 Morrill Act, which laid the groundwork for the nation's unparalleled public univer-

**The Academy created the Lincoln Project to examine the importance of public research universities, analyze economic trends affecting their operations, and recommend new strategies to sustain these institutions.**

sity system. That system resides alongside the system of private universities. Both are important in the spectrum of higher education offerings in this country, and we have no interest in creating a divide between the two sectors.

However, public universities and colleges, which we believe are key to economic growth, innovation, and upward mobility, are facing enormous challenges that have been developing over the last thirty or forty years and have really intensified over the last decade, particularly in light of the great recession. Part of the role of the Lincoln Project is to highlight these intense challenges.

Our wonderful project advisory group is drawn from the membership of the Academy as well as from the higher education sector, the government sector, the private sector, the high tech world, and news and media organizations. We have held regional meetings around the country for the last two years and have been excited to see examples of the enormous creativity that exists in the public higher education sector.

The first thing we had to decide was which cohort of universities we would study. We felt it was important for us to have an envelope around this so that the questions we were asking and the issues we were trying to address really related to the public research university. So we started with the Carnegie definitions. One hundred eight universities, both public and private, fall into the "very high research activity university" category; ninety-nine are in the "high research activity" category, and seventy-nine are in the "research university" category.

Among the universities in the very high research activity category and the high research activity category, 143 are public universities, and every state has at least one. This group became our study cohort.

We chose to focus on public universities in part because their broad distribution across the states (every state has at least one very high research activity or high research activity university) will make getting the public's attention easier and because the private universities in the two highest Carnegie classifications, wonderful as they are, educate only 474,000 undergraduate students. The public universities in these two categories educate 2.75 million undergraduate students. This is a huge disparity and one of the reasons we believe it is so important to the nation that we find ways to preserve this sector.

A similar imbalance holds true at the graduate student level. The private universities in the very high research activity and high research activity categories educate 288,000 graduate students. The public universities educate 615,000 graduate students.

So what's happened in student enrollment? Despite the devastating cuts in public higher education funding in the last decade, especially through the recession, public research universities have continued to increase enrollments and to educate more students than the private universities. Public research universities today are doing more with less.

At the same time, private research universities with large endowments have been able to lavish resources on students. This is a



good thing. But it has put tremendous pressure on public research universities. Without comparable resources, they have had to restrain their costs and expenditures while still trying to educate students, keep quality high, compete with their public and private counterparts, and still serve the nation in the way we all feel is important.

So what about access? One of the reasons Lincoln signed the Morrill Act was to make higher education available to citizens of all types. How well are the public research universities doing in that regard? Arguably they are meeting the mandate. Almost 29 percent of their students are low income. The public universities also educate a higher percentage of low-middle-income and middle-income students.

In addition to educating students from across the economic spectrum, both public and private universities have been doing ex-

to the day when states covered 70 percent of the cost of an undergraduate education and families covered 30 percent. The overall percentages are now almost reversed: families at 70 percent and the state at 30 percent or less, with some institutions receiving much, much less in state support.

What is causing this problem? The Lincoln Project's second publication deals with the budget landscape higher education now faces. Elementary and secondary education – which is very important in this country – takes the lion's share of states' budgets. Medicaid – a fixed cost the states cannot avoid – is another major competitor for funds. Higher education and corrections spending are then almost neck and neck.

One of the things we found most interesting as we got into this study was the vast difference in how the states support public higher education. At the high end for per

## **Philanthropy will be a major part of the funding model for public universities in the future, so we need to understand what successful philanthropy models look like and how to encourage foundations to look more to the public sector for their funding targets.**

student expenditures were Alaska and Wyoming, each spending more than \$16,000 per full-time-equivalent student. At the low end were Arizona and New Hampshire, each spending less than \$4,000 per student. We would love to see the states set a floor, commit to a minimum level of support for higher education.

Another driver of increasing tuition has been rising pension costs. In Illinois, for example, recent increases in the higher education budget might lead you to conclude that public universities there are recovering. In fact, most of the increase has gone to pay for higher pension costs.

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Other topics we are looking at are how to diversify funding and the importance of operational efficiency. Philanthropy will be a major part of the funding model for public universities in the future, so we need to understand what successful philanthropy

If we look at where else spending is increasing in state budgets, we find that one of the biggest growth areas is corrections, which will soon overtake higher education as an expenditure. That is, states may soon spend more to put people in prison than to educate them for the future. Already the state of Michigan spends more on corrections than higher education, and I think California does, too.

What did we conclude from our regional meetings? First, state disinvestment is a nationwide phenomenon. We would like to stop it, reverse it if we can, and we are going to talk about it at every opportunity, but we suspect it is irreversible. Second, disinvestments have been offset by increases in tuition. Third, commitment to access varies widely among states. Fourth, and something we found enormously encouraging, public research universities have reacted to the worsening conditions with a level of creativity that, frankly, surprised us; for example, they have been optimizing their position in the local context. That is an important outcome.

Something we hear a lot of talk about is technology and how it is going to reduce the cost of higher education. The most cited example here is online courses. A much more interesting dynamic, however, is how technology can help us learn more about students (for example, through data collection) in order to better personalize their education and track their progress. We think universities can effect dramatic improvements in graduation rates by improving their ability to know how students do in courses and using predictive analytics to help get them through their undergraduate education.

Other topics we are looking at are how to diversify funding and the importance of operational efficiency. Philanthropy will be a major part of the funding model for public universities in the future, so we need to understand what successful philanthropy

## *Commission on the Future of Undergraduate Education*

models look like and how to encourage foundations to look more to the public sector for their funding targets.

We also want to identify at the federal level some opportunities for increased public and private investment, and perhaps combined investment, in public research universities. And while we understand the social and the economic pressures the states are facing, we also believe they need to recognize the value of these universities and thus base future funding goals on an appraisal of how they benefit local communities, states, and the nation.

Universities themselves will need to take charge of operational efficiency, doing all they can to remain competitive with their private counterparts while addressing budgetary limitations responsibly and in such a way as to remain attractive candidates for both public and private investment.

Finally, the business world has benefitted enormously from what our public research universities produce: educated employees and consumers, and research and technology that spur innovation. So we are going to recommend more direct private investment in public higher education.



**Don M. Randel**

*Don M. Randel, a Fellow of the American Academy since 2001, is Chair of the Board of the American Academy of Arts and Sciences.*

The work of the Lincoln Project has made clear one aspect of the desperate situation in which higher education finds itself in this country. It represents a huge disinvestment on the part of the public in what ought to be a public obligation to the citizens of the country. I give you but one statistic. In 1995, the United States was ranked first in the world in the percentage of its citizens who held university degrees. By 2014, we had descended to number nineteen out of the twenty-eight most developed countries. This cannot be good for the future of the nation.

In the wake of the work of the Lincoln Project, the Academy believes we need to step back and take a view of higher education as a larger system, one that includes different kinds of institutions, and try to understand the relationship of these institutions to one another. One of the first and most pressing tasks in this work is to try to dispel the substantial amount of misinfor-

**The Commission on the Future of Undergraduate Education will take a broad and deep look at the entire system of higher education and try to dispel the substantial amount of misinformation that emerges in the debate about higher education.**

mation that emerges in the debate about higher education. A very great deal of what we read in the public press is either mildly or entirely misinformed about how the system works.

Simultaneously, we have to take into account the fact that we live in a nation with no national higher education policy. We have a Department of Education, and while the Secretary of Education has a few carrots, the office has absolutely no sticks with respect to how higher education goes in this country. The states and localities are left alone to do what needs to be done for public higher education, and there are wide disparities from one state or community to another.

The result is a system that reminds one of the Wild West. Instead of providing access to higher education broadly and funding it the way other developed countries do – namely, through a progressive tax code – we leave each of the 4,500 institutions of higher education – both public and private – to figure out how to redistribute income so as to enable the less well-to-do to have access to higher education along with the well-to-do.

The direction we are headed, in which the burden increasingly is placed on the backs

of students and parents except in a few very wealthy institutions, leaves each institution to figure out how to do this on its own.

When we talk about the high cost of education, what is usually meant is how high tuition is without taking into account what the average student actually pays to go to a university, whether public or private. The discussion leaves out the fact that many private institutions that are thought to be wealthy are in fact discounting their tuition by 50 percent or more, and it leaves out the way in which the public universities are more and more forced to find ways to redistribute income in order to make good the loss of public funds.

So we increase tuition for out-of-state students in order to pay for in-state students. We increase financial aid out of the tuition paid by well-to-do students so as to make possible the education of the less well-to-do. We face the very real danger that higher education in America, instead of being the great force for the amelioration of income inequality, becomes a system that exacerbates income inequality.

The rich will always have places in higher education, and a few institutions will always be able to afford from their own resources to educate some modest number of the less well-to-do, but the system as a whole is in a deeply troubling situation, and unless something is done to reverse that we shall have only ourselves to blame for a declining presence in the world as a great leader – not only as an economic power but as a great leader in ideas and as a force for good for people around the world.

We love to brag about a certain group of distinguished private universities in this country, but the truth of the matter is that only four are truly wealthy institutions. (They start with the letters H, Y, P, and S.) Even institutions you might think have big endowments – six billion dollars or thereabouts – are deriving at best only about 15

percent of their annual income from those endowments. These institutions, which are leading privates, are as tuition-dependent as many of the institutions you have never heard of, and still they are doing the teaching and research that benefits the public right alongside the great public institutions.

The Commission on the Future of Undergraduate Education will therefore take a broad and deep look at the entire system of higher education, if *system* be the word for it, and try to understand how we can frame recommendations or, at a minimum, how we can get the attention of the public and dispel some of the terrible misinformation that has guided or not guided the public debate.

We have before us in Congress people who would like to get rid of the Department of Education altogether, people who think that the more you privatize the better, the less government the better. But somebody has to assume the responsibility for the future well-being of this country, which surely rests within higher education as much as anything. There is no more important issue before the public today than higher education, and the Academy will do its best to clarify the issues involved and to see a better set of outcomes than, alas, we can now contemplate.



# Global Security and International Affairs

## *Committee on International Security Studies*



### Steven E. Miller

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

The Committee on International Security Studies is perhaps the longest-standing committee of the Academy. It originated in a summer study group that started in 1958 and then over a period of several years did absolutely formative work in establishing the notion of arms control as a useful instrument of national policy in the area of defense. The group's work led to a 1960 special issue of *Dædalus* that is usually described as "the bible of arms control." Among the authors were Henry Kissinger, Thomas Schelling (later a Nobel laureate in economics), Paul Doty, and many other people who are regarded as giants in the field of arms control and nuclear policy.

After this initial period, the group transformed into a standing committee that has

### **How do we prudently and safely manage the nuclear technology that some of our intellectual forefathers vividly described as "species-threatening"?**

sustained itself for some five decades. Along the way the committee has addressed such issues as ballistic missile defense ("Star Wars") in the 1980s, and questions of sovereignty and intervention in the context of Bosnia and the terrible crisis in southeast Europe in the 1990s.

In more recent years we have completed a major project on security among the post-Soviet states that emerged from the collapse of the Soviet Union, looking at how to reorder that space in a way that minimizes the likelihood of large-scale violence. We have also done work on the military uses of space, with the objective of creating structures of governance in what is otherwise an ungoverned environment.

We are just now launching two projects that will figure importantly in the next phase of the Committee's work. One of these, led by Robert Legvold of Columbia University, will move forward under the heading "Understanding the New Nuclear Age." In a way it harkens back to the same set of issues that animated our colleagues in 1960: how do we prudently and safely manage the nuclear technology that some of our intellectual forefathers vividly described as "species-threatening"? And how do we do so at a time when the deterioration in U.S.-Russian relations has produced something akin to the old Cold War sentiments?

Worse, many of the treaties, institutions, and policy frameworks that were employed during the Cold War to govern the nuclear relationship with Moscow either no longer exist or have been allowed to decay. The Anti-Ballistic Missile Treaty is no longer in effect because the United States withdrew from it. The strategic arms control pro-

cess that structured the dialogue on nuclear issues between Moscow and Washington has been allowed to lapse. The partnership forged between Moscow and Washington on cooperative threat reduction to minimize the likelihood of loose nuclear weapons and materials has collapsed.

Governing structures have decayed even as many of the risks that were embedded in Cold War nuclear postures remain strikingly unchanged from Cold War days. So, this new project will consider how the nuclear relationship has changed, what risks we

### **What are the security challenges that arise when states begin to disintegrate? What policy options are available to the United States and the world to address these terrible security and humanitarian challenges?**

now face in light of current technological and geopolitical environments, and how we can revive arms control in such a way as to provide prudent management of what is the world's most dangerous relationship.

The second project that is getting underway focuses on fragile states. In Syria, Libya, Iraq, Afghanistan, Sudan, Somalia, the Democratic Republic of Congo, we see



## The Global Nuclear Future

acute human tragedies and intractable political land security challenges that arise from the inability of states to establish full sovereignty over their territories. When such states weaken and collapse, difficult challenges and painful choices are pressed onto the world community and onto the American national security agenda. What to do? What will work? Why does this happen? How can we remedy these problems?

Under the leadership of Karl Eikenberry – now at Stanford University, former U.S. Ambassador to Afghanistan, and a retired U.S. Army Lieutenant General who served in Southwest Asia and has firsthand experience with some of the implications of failed states – we are going to look at why we are seeing this epidemic of state failure. What are the security challenges that arise when states begin to disintegrate? What policy options are available to the United States and the world to address these terrible security and humanitarian challenges? Can we divine from the historical evidence of recent experience some sense of what might actually work?

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### Robert Rosner

*Robert Rosner is the William E. Wrather Distinguished Service Professor in the departments of Astronomy & Astrophysics and Physics at the University of Chicago, as well as in the Enrico Fermi Institute, the Computation Institute, and the Harris School of Public Policy Studies. A Fellow of the American Academy since 2001, he serves as a member of the Academy's Council and as Codirector of the Global Nuclear Future Initiative.*

The Global Nuclear Future Initiative is a great example of how you can be drawn into activities at the Academy. The project, started by my two colleagues Steven Miller and Scott Sagan, began with broad participation from individuals who are members of the Academy and from individuals who are not members, and with very generous funding from the MacArthur, Hewlett, and Sloan Foundations and Carnegie Corporation of New York.

So the key question, of course, is why this project? Clearly the nuclear renaissance has not happened in the United States, but it is happening in other parts of the world, in particular in the Middle East and in South-

**We have focused on a group of countries where nuclear construction activities have already begun or are soon going to start.**

east Asia, and so that has been the focus of our work. Specifically, we have been focusing on the question of how nuclear power can proceed in states that may not yet have the necessary technological and human resources to work with nuclear power in a way that we would regard as safe and secure.

In addition to a few legacy countries such as Japan and South Korea that have been major factors in the nuclear industry worldwide, we have focused on a group of countries where nuclear construction activities have already begun or are soon going to start. These include Vietnam, the United Arab Emirates (in particular, Abu Dhabi), Turkey, Jordan, and Malaysia.

The three foci of our studies are nuclear safety and liability; the question of what happens to used fuel once it leaves the reactors in countries that are typically not yet prepared to deal with it (what makes us nervous is that neither are we prepared; we have simply pushed the issue aside, and now we worry the same will happen in these countries); finally, the issue of nuclear terrorism and the problem of insider threats. No one of these issues is really distinct from any of the others. They are all interconnected.

Academics and Americans love to tell other people what to do; it is in our nature. But that behavior is not often welcomed, and because we understood this from the outset, we chose instead to engage with folks in a collaborative way. We have brought them into the discussions, and the publications we have produced are authored not just by us but also



## *New Dilemmas in Ethics, Technology, and War*

by them. We don't just talk about the nirvana we would like to get to; we also talk about how we might get there. To encourage open, frank discussion, we operate on the Chatham House Rule and do not attribute particular statements to particular individuals. We try to maintain confidentiality.

As befits academics, we have done a lot of work and produced many publications, including two issues of *Dædalus* and a series of occasional papers published by the Academy and coauthored not just by us but by regional experts as part of the collaborative spirit we have tried to foster. We have organized regional conferences that involve the key stakeholders from government, from civil society, from academia. We have held policy briefings with government officials and representatives of the international nuclear industry.

Every year our agenda is full. Most recently, in January 2015, we were in Abu Dhabi looking at the site where the South Koreans are building four nuclear plants, discussing with the nuclear regulator in Abu Dhabi how they are going about things. We have dealt with a spectrum of similarly interesting issues, from governance to business models to dual use to interim storage of used fuel.

Our next steps include developing a model legal framework for bilateral or multilateral interim storage facilities and consolidating a partnership with the ASEAN countries to develop a regional roadmap for nuclear safety, security, and nonproliferation. We also plan to publish a book on the best practices for managing insider threats and an analysis of contemporary dual-use governance strategies.



**Scott D. Sagan**

*Scott D. Sagan is the Caroline S. G. Munro Professor of Political Science and Senior Fellow at the Center for International Security and Cooperation and the Freeman Spogli Institute at Stanford University. He was elected a Fellow of the American Academy in 2008 and serves as Chair of the New Dilemmas in Ethics, Technology, and War project as well as a senior advisor to the Global Nuclear Future Initiative.*

Technological developments and changes in the nature of the conflicts we are engaged in have led to many challenges to our efforts to follow the laws of armed conflict and the principles of just war doctrine. Advances in precision-guided munitions placed on drones, for example, not only enable us to target individuals with far more accuracy and discrimination than ever in the past, leading to reductions in collateral damage, but also provide temptations to use that force in more places more often, potentially leading to larger amounts of collateral damage.

Understanding that many technological developments and changes in the nature of conflicts are poorly understood, the Acad-

emy has gathered together a very interesting group of individuals, interdisciplinary in nature, mixing practitioners and scholars with a wide range of people: scientists and soldiers, theorists and theologians, poets and pilots.

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Next year the Academy will publish two issues of *Dædalus* that feature essays written by some of the members of the New Dilemmas in Ethics, Technology and War project. Many of the articles will be normative in subject matter, but empirical in orientation. That is, many of the authors are focusing not only on what soldiers and statesmen *should do* from a normative perspective, but also on how soldiers and statesmen *actually behave* in war. They include political scientist Joseph Felter from Stanford, who with Jacob Shapiro from Princeton is studying whether the efforts of the U.S. military to reduce collateral damage in Afghanistan and Iraq, by employing what was called the “doctrine of courageous restraint,” produced the hoped-for result of decreasing Taliban recruitment in Afghanistan and increasing the willingness of local villagers to provide information to the allies. Did that happen or didn't it? Similarly, Brigadier General Mark Martins, the chief prosecutor at Guantánamo in the Khalid Sheikh

Mohammed trial, is writing a paper on war crimes trials. When do they work and when do they potentially backfire? What does the historical record tell us?

Tanisha Fazal, a political scientist at the Peace Studies Institute at Notre Dame, is writing about what we know about when and why some insurgent groups, some rebel groups, follow the laws of armed conflict and others do not. What empirical information do we have, and how do we explain those differences?

the United Nations and how it is changing given the experience of the Arab Spring and the great difficulties that followed.

Janne Nolan from George Washington University and Antonia Chayes from Tufts are writing a paper that focuses on questions of responsibility after war and what we know and now think given the recent war experiences of the United States.

Finally, the project has included prose writers and poets to broaden our perspective. At our recent authors' workshop at

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Lloyd Axworthy, the former Foreign Minister of Canada, and Walter Dorn, a chemist at the Royal Military College in Canada, are writing a joint paper on improved warning indicators for civil strife that could lead to civil war.

Paul Wise from Stanford and Jennifer Leaning from Harvard are two medical doctors in our project trying to understand how best to predict emerging conflicts and to predict the consequences of such wars. It is important to note that there are often serious postwar failures in a country's medical services, costs that are rarely understood in advance of war. If we systematically underestimate the long-term medical costs of war, shouldn't we take that into account when we think about proportionality not only during conflicts but especially when contemplating whether to use military force at all?

Jennifer Welsh, the United Nations Secretary-General's Special Adviser on the Responsibility to Protect and a professor at Oxford and the European University, is writing on the responsibility to protect doctrine of

Stanford, Phil Klay and Natasha Trethewey considered how literature reflects our common memory and how humor can be used to help soldiers deal with the activities they have engaged in and the horrors they have seen in war. Phil Klay is a Marine Corps veteran of the Iraq War and a National Book Award winner for his wonderful collection of short stories, *Redeployment*. Natasha Trethewey is a former U.S. poet laureate, a member of the Academy, and a Pulitzer Prize winner for *Native Guard*, a book of poetry written in the voice of a black Civil War soldier who is guarding former slave owners in a Confederate prison run by the Union Army in Louisiana. We need such perspectives to ground our understanding of just and unjust wars in the real experiences of men and women on the battlefield and behind the lines.

## New Dilemmas in Ethics, Technology, and War



### Antonia Chayes

Antonia Chayes is Professor of Practice in International Politics and Law at The Fletcher School of Law and Diplomacy at Tufts University. She is a member of the Academy's project on *New Dilemmas in Ethics, Technology, and War*.

What comes next? This is the question we are asking as catastrophes unfold from Mosul in Iraq, Kunduz in Afghanistan, and throughout Syria. The essay that Janne Nolan and I have written for the project on *New Dilemmas in Ethics, Technology, and War* attempts to understand and explain how the United States and its allies fail to plan for the aftermath of conflict. This is both a failure of strategic analysis and a major ethical issue.

As Michael Walzer has written, “the argument about ending is similar to the argument about risk.” Once we have acted in ways that have significant negative consequences for other people, even if there are also positive consequences, we cannot just walk away.

Imagine a humanitarian intervention that ends with the massacre stopped and the murderous regime overthrown but with

**Investment in post-conflict societies often seems difficult, but it is still cheaper than maintaining an occupation force for years beyond local tolerance. In the end, *jus ad bellum*, the decision to engage in a just war, does require *jus post bellum*, full consideration of what comes next.**

the country devastated, the economy in ruins, the people hungry and afraid because law, order, and any effective authority have vanished. The forces that intervened did well, but they are not finished. How can this be? How can victory be declared until some measure of recovery is achieved and the state can be accepted into the international community?

Likewise, logic would seem to require that, in debating how to respond in another country, policy-makers also analyze the consequences of nonintervention or even providing military assistance and training. If a nation collapses into chaos, sending refugees streaming throughout the world, what ethical or strategic objectives do stable governments have?

Nor are these all recent failures. In the United States the aftermath of the Civil War was not thought through. The dire reparations after World War I generated resentment among Germans who did not believe they had started the war or been defeated. Even the end of World War II, crowned by the Marshall Plan, almost succumbed to the draconian measures of the Morgenthau Plan, which would have dismantled German industry and reduced the country to an agrarian economy with reduced territory. The first Gulf War, touted as a success, left a sectarian residue to fester. And Iraq 2003 is a canonical case of military myopia and unrealistic optimism.

Why all these failures to learn? Systems are in place in the United States and the Na-

tional Security Council, in the UN Security Council, and in allied capitals, but they are underutilized. In our forthcoming paper we examine a few possible explanations.

First, the United States continues to rely on its advanced technology and fails to look beyond. Also, our constitutional system makes adaptation difficult once a consensus has been put together – a topic about which Janne has written a whole book. Deep civil-military dialogue is lacking, and diplomats are uncomfortable with systematic planning – a topic that I discuss in my book *Borderless Wars*. Bureaucracy continues to exercise its repertoire, as both Robert Komer and Graham Allison have described. Donors look to international legitimacy, and while they seek self-protection from further conflict, they fall short even of that goal. No one is in for the long term.

Investment in postconflict societies often seems difficult, but it is still cheaper than maintaining an occupation force for years beyond local tolerance. In the end, *jus ad bellum*, the decision to engage in a just war, does require *jus post bellum*, full consideration of what comes next.

# Science, Engineering & Technology

## *Science, Engineering & Technology*



### Venkatesh Narayanamurti

*Venkatesh Narayanamurti is the Benjamin Peirce Research Professor of Technology and Public Policy at Harvard University. He was elected a Fellow of the American Academy in 2007 and serves as a member of the Academy's Board of Directors and as a member of the Academy's Council.*

In 2008, the Academy published a report addressing two key issues: the support of early career investigators and the encouragement of high-risk, high-reward research. The project was called Advancing Research in Science and Engineering, or ARISE for short. The study's recommendations were addressed to the major funding bodies – the U.S. Department of Energy, National Institutes of Health, National Science Foundation – and encouraged them to increase support for early career researchers and transformative research. The findings were incorporated into the American Research and Reinvestment Act as well as subsequent federal legislation.

Five years later the Academy published a follow-up report called *ARISE II: Unleashing America's Research and Innovation Enterprise*.

**Because of advances in the areas of computational biology, systems biology, and biologically inspired engineering, we concluded that much stronger bonds need to be forged among these diverse areas.**

The project committee, which I chaired with Keith Yamamoto from the University of California, San Francisco, examined the U.S. research system with a special focus on the research university and two critical stakeholders: federal funding agencies and industry.

At the time, we were seeing a tremendous change in the scientific landscape; namely in the physical sciences and engineering and in the life sciences and medicine. Because of advances in the areas of computational biology, systems biology, and biologically inspired engineering, we concluded that much stronger bonds need to be forged among these diverse areas. We labeled this deeper union “transdisciplinary research.”

The physical sciences and engineering in academia have a long history of transferring knowledge to and working with industry. This was especially the case with the great industrial laboratories of the past. But changes in industry have placed these connections under great stress. We concluded that new models of collaboration between academia, government, and industry are needed to bridge these areas and that interdisciplinary research needs to become transdisciplinary research.

This past year the Academy published *Restoring the Foundation: The Vital Role of Research in Preserving the American Dream*, which was produced by a panel cochaired by Neal Lane and Norman Augustine. The report assesses the health of the research system and concludes that the country is falling behind in various ways. For example, research funding has not kept pace with our gross domestic product, and innovation policy has

not kept up with the work of academia and industry.

Among the panel's recommendations are three overarching prescriptions. The first is to secure America's leadership in science and engineering research, especially basic research. To do so, we need to develop sustainable, long-term investment goals – a certain percentage of the GDP probably should be going toward basic research, for example. Second, we need to ensure that the American people receive the maximum benefit from publicly funded research. Third, we need to establish a new, robust partnership among academia, industry, and government.

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## New Models in U.S. Science and Technology Policy



**Nancy C. Andrews**

*Nancy C. Andrews 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 was elected a Fellow of the American Academy in 2007 and serves as a member of the Academy's Board of Directors. She is also a committee member for the New Models for U.S. Science and Technology Policy study.*

**R**estoring the Foundation asserts that American science, engineering, and technology research is at a critical inflection point and that the decisions of policy-makers and leaders over the next few years will determine the trajectory of American innovation for years to come. The report describes the challenge that lies before us and is meant to serve as a call to action. In the words of Norman Augustine, who cochaired this report with Neal Lane, we must start to think about our future if we hope to have a future.

Looking back, America's post-World War II rise to international preeminence in science and technology was truly remarkable and attributable to decades of invest-

ments made in research and education. We see the benefits in our own lives. Our life expectancy in America today is nearly twice that of our grandparents because devastating infectious diseases have been conquered and conditions like cancer and coronary artery disease are much less likely to be lethal.

**As our investment has languished, other countries have recognized how vital a strong research enterprise is for economic growth and for their citizens' quality of life. In less than ten years, if current projections hold true, China will outspend the United States in research and development both in absolute terms and relative to the overall economy.**

Because of basic scientific research, we carry pocket devices that not only let us communicate from almost any place on earth – and take selfies – but they can instantly provide more information than most libraries. The past seventy years of research and innovation have also provided enormous economic benefits: new efficiencies, new businesses, and new careers.

But America's future does not look as bright. We can no longer claim preeminence in a number of areas that we have taken for granted. Our students now rank seventeenth in the world in reading, twentieth in science, and twenty-seventh in math. As a country, we are seventh in the world in basic research investment, and we have dropped from first to tenth place in total R&D investment.

As our investment has languished, other countries have recognized how vital a strong research enterprise is for economic growth and for their citizens' quality of life. In less than ten years, if current projections hold true, China will outspend the United States in research and development

both in absolute terms and relative to the overall economy.

The rest of the world is now trying to emulate what America once did.

Technological advancement relies on breakthrough discoveries that come out of fundamental curiosity-driven basic re-

search, most of which is government funded. Innovators and entrepreneurs create new jobs for a broad spectrum of Americans, and they could not do so without basic research. Yet since 2003 the federal basic research investment, as a percentage of the GDP, has dropped by 13 percent, and the funding landscape has become a roller coaster.

We risk losing the advantage America has long held as an engine of innovation – an engine that not only generates new knowledge and products but new jobs and industries. Business agrees. The project committee for this report consists of twenty-five leaders from all corners of the research enterprise, from government, universities, and corporations.

At its release, *Restoring the Foundation* was immediately endorsed by Merck & Co. and by the Business Roundtable. The Council on Competitiveness, which represents CEOs of major corporations, university presidents, and the heads of national labor organizations, supports our message. They agree that any national strategy addressing jobs and the economy must have a focus on innovation and competitiveness.



In February a closed-door roundtable was held in the U.S. Capitol Visitor Center that brought together nearly thirty CEOs and NGO presidents with a bipartisan, bicameral group of congressional members. The event was organized in coordination with Senator Chris Coons's office and was attended by Representative Randy Hultgren, Representative Derek Kilmer, and Senator Dick Durbin. Senator Lamar Alexander was unable to be present but wrote a brief statement of support that was delivered at the meeting.

Those in attendance expressed broad agreement that basic research investments are critical for industry and the economy and that it is the role of the federal government to make those investments.

Over the past year, the Academy has organized dozens of meetings across the nation and in our nation's capitol. Committee members have been invited to present the report at professional society meetings and to federal agencies. They have participated in more than fifty meetings with members of Congress and their staff, including congressional briefings.

Recently, *Restoring the Foundation* cochair Norman Augustine was invited by the Senate Commerce Committee to participate in a roundtable discussion to identify priorities for the Senate version of the 2015 America Competes Act. Norm and his *Restoring the Foundation* cochair, former White House Science Advisor Neal Lane, also submitted a letter addressing Commerce Committee questions on how to maximize the impact of basic research. The invitation for the Academy to participate in these conversations signals Senate leaders' recognition of the work of Norm, Neal, and our entire *Restoring the Foundation* committee.

*Restoring the Foundation* also inspired the statement "Innovation: An American Imperative," which supports many of the report's recommendations. Nine CEOs of ma-

major corporations signed on, including Marilyn Hewson from Lockheed Martin, Jim McNerney from Boeing, Sam Allen from John Deere, and Satya Nadella from Microsoft. Many universities and academic societies also signed.

The American Academy is working with ten other organizations, including the American Association for the Advancement of Science, the Association of American Universities, and the Association of Public and Land-Grant Universities, to organize an event in Washington on October 20, 2015, to call greater attention to this statement and to the report recommendations. Norm Augustine will be speaking along with Jeanette Wing from Microsoft and Roger Perlmutter from Merck. We are gratified that so many other organizations have joined the Academy in carrying the report's recommendations forward. The Academy will continue to work with our partners in the years ahead to bring greater visibility to key policy issues pertaining to basic research both in Washington and across the nation.

## Public Understanding of Science



### Richard A. Meserve

*Richard A. Meserve is Senior Of Counsel in the Washington, D.C., office of Covington & Burling LLP. He is President Emeritus of the Carnegie Institution for Science and previously served as Chairman of the U.S. Nuclear Regulatory Commission. He was elected a Fellow of the American Academy in 1994 and serves on the Academy's Council and Trust. He is also a member of the advisory committee to the Academy's Global Nuclear Future Initiative and of the Science and Technology policy study group.*

I think all of us are aware of the great significance of science and technology in our lives. They affect personal decisions we make about our healthcare and what we eat, and they have enormous importance for a wide range of crucial public issues such as climate change, the future trajectory of energy and water usage, how we deal with a growing world population, protecting endangered species, and on and on.

People in the scientific and technological world can provide information on those topics to ordinary citizens to help them make important decisions. As a result, the interface between scientists and the public

**The intent of the Academy's new project is to understand at a much deeper level than we do today the issues of trust, engagement, and perception that impact the interface between scientists and the general public.**

is crucially important, but we confront challenges in assuring adequate information flow. The Academy is thus embarking on a new project that is intended to deal with these challenges.

Data from the Pew Research Center show that, despite a slight decline over time, the public has a generally positive view about the contribution of science to society. The vast majority of people believe that science has made life better for most people, and they have a favorable view of the contributions of science and technology to healthcare, food and the environment, economic development, and many other areas. The Pew data also show that scientists are among the most respected professionals in the United States.

The foundation for communication with the public on scientific and technical issues is thus strong. The problems arise when you turn to specifics. For example, an astonishing fifty-one-point gap exists between what scientists understand about genetically modified foods and what the public thinks. Similarly, there is a forty-two-point gap concerning the use of animals in research and an almost identical gap in views of the safety of foods grown with pesticides.

The data show that 65 percent of the public believe human beings evolved over time, but only a third of the public believes that human evolution was guided by natural selection. Many respondents have the view that a supreme being controlled evolutionary change.

Other issues, too, show gaps between what the public understands and the views

of the scientific community: whether childhood vaccines should be required (an 18 percent gap), whether climate change is due to human activity (a 37 percent gap), or whether a growing human population will be a major problem (a 23 percent gap).

One should not assume, however, that scientists are universally in favor of all technology. The scientific community is more pessimistic than the public about, for example, whether astronauts are essential for the future of the U.S. space program or whether we should undertake increased offshore drilling for oil or should further exploit fracking to recover natural gas. In each instance, the scientific community has a more negative view than the public of these activities.

It is no doubt the case that a core problem relates to science education – namely, the reality that the public doesn't understand science because they haven't been taught well enough. That is a foundational problem. And while science education is no doubt the most significant factor in the gulf between the understanding of scientists and that of the public, the data show that other factors are at play too.

For example, attitudes about evolution are affected by religious beliefs. Climate change issues are strongly correlated with political ideology and age. Men and women differ on the use of animals in research and on various energy questions. No doubt many other factors also affect how receptive people are to scientific information.

The intent of the Academy's new project is to understand at a much deeper level than

we do today the issues of trust, engagement, and perception that impact the interface between scientists and the general public.

The aim is to understand the factors that affect the public's willingness to accept knowledge from the scientific community. The work will involve scientists and technologists, but it should also draw from a broad segment of the Academy, including members who are involved in education, communications, and journalism.

regard, the constantly changing guidance of foods to eat or avoid.

The media are an important intermediary between the scientific community and the public. As part of the project, there will be opportunities for Academy Fellows to interact with young, talented journalists – for example, through the Knight Science Journalism program at MIT or with the Nieman Foundation Fellows at Harvard – to explore means to improve communication. But we

### **The aim of our project is to understand the factors that affect the public's willingness to accept knowledge from the scientific community.**

Probably a critical factor is the way in which scientists engage with the public. Scientists often have a difficult time describing their fields to the general public. Many scientific fields use specialized language that experts grow accustomed to using and then have difficulty avoiding in public communications. Moreover, scientific experts fear oversimplification without recognizing that there may be nuances that are of great significance within the field, but are irrelevant or tangential to the general public.

Another challenge for the public is the determination of whom they should believe. Members of the general public who want information may not know how to identify reliable sources or make sense of experts' dueling claims (a challenge we frequently confront, for example, in the public discussion of climate change). You can find support for nearly any proposition on the Internet, which only compounds the problem of distinguishing a reliable from an unreliable source. An additional complication is that scientific positions evolve over time. The apparent inconsistency in scientific consensus can impact the public's confidence in scientific information. Witness, in this

will have to reach out to a broader community, too, because traditional newspapers are no longer the only important sources of information for the public.

Lastly, we contemplate exploring issues that relate to how scientists are consulted during public decision-making processes. For example, what is the role of science in the legal system? What are the barriers to effective engagement? What role can science play both during man-made and natural disasters and in preparing for such disasters? We have been interacting with the U.S. Department of the Interior to consider how we might better use science both ahead of time and during an accident to guide government actions.

The Public Understanding of Science project is still in the gestation phase. And because it is such an important project, I invite all of you to get involved in shaping it or in contributing your expertise.

# Exploratory Projects, Projects under Consideration, and the Future

## *Exploratory Project: Access to Justice*



### Martha Minow

*Martha Minow is the Morgan and Helen Chu Dean and Professor of Law at Harvard Law School. She serves as Vice Chair of the Board of the Legal Services Corporation. She was elected a Fellow of the American Academy in 1992.*

Despite constitutional commitments to equal justice for all in this country, access to justice has actually declined in the United States in the last ten years. Income and status sharply affect the nature of justice and the experience of justice in America, and the Academy's attention, we believe, can make a real difference in this crisis that is affecting both civil and criminal justice.

We will be hosting a conference at the Academy on November 11 and 12 that will bring together judges, lawyers, and legal scholars concerned about the state of legal services for low-income Americans. The Constitution guarantees access to a lawyer when someone faces jeopardy and the loss of his or her liberty, but that guarantee, while beautiful, has not been delivered in practice. Many people around the country who face jail time have no lawyer at all. Many are pressured to bargain for some

kind of reduction in charges without any lawyer to give them advice.

Few jurisdictions comply with the most recent Supreme Court judgment on the subject, *Alabama v. Shelton* in 2002, which guaranteed a right to counsel for people receiving probation or suspended sentences. Only a few jurisdictions have the ability to provide counsel in those circumstances. And even where lawyers are provided, often it is in name not reality.

best scenario – in cases where there is a public defender.

Even when an indigent defendant has access to a public defender, there is a fair question about the independence of the public defenders. Studies show that in some parts of the country the public defenders are not independent. They face political pressures to accept pleas or to handle individual cases in particular ways. Public defenders particularly lack independence when it comes to

**Despite constitutional commitments to equal justice for all in this country, access to justice has actually declined in the United States in the last ten years.**

Public defender caseloads so far exceed the national standard of no more than 150 felony cases per attorney, and that is an embarrassment. New York State is one example where the standard caseload is twice the national stated goal. But that is actually better than most jurisdictions. The typical caseload for public defenders in the United States is 1,600.

This is a crisis and results in miscarriages of justice every day. Triage is inevitable. Any public defender's office is like a battlefield, and the shortfalls in quality of representation are nothing short of shocking. And this doesn't even reach the question of whether the right to public criminal defense includes access to investigators, to scientific testing – all of which costs money.

The criminal justice system does not work the way it is portrayed on television. We do not have trials. We do not have CSI and CIS as routine resources. Thus, in the daily routinized criminal plea bargains and scattered trials in this country, we do not have that kind of evidence and that kind of defense. The government commonly spends three times as much to prosecute a case as it spends on public defense, and that is in the

any decision that affects resources, such as access to investigators, to DNA testing, or to any other kind of expenditure.

These difficulties are embedded in a larger criminal justice system that is going through a severe crisis resulting from a lack of training for law enforcement. We have all watched the tragic shootings of individuals across America by law enforcement officers who lack training or who may feel their own lives are threatened and don't understand how to manage those threats.

The patterns of racial disparity are so staggering and shocking they are affecting our standing in the world, not to mention our conscience. And that is all in the context of the contemporary United States having the dubious distinction of being the most incarcerated country in the history of humanity.

The Department of Justice issued a powerful report identifying how in Ferguson, Missouri, the criminal justice system is dependent on court fines, producing incentives for more arrests and more punishments. Despite laws against debtors' prisons in America, we do have debtors' prisons in America. These are deep, deep problems.

The civil justice side is not any better. We have record levels of people in poverty in America right now, and yet in the last few years we have seen a reduction in support for low-income people seeking access to justice. In just the last year, 54 million people became eligible for legal services in America. We have resources for maybe 20 percent of those, meaning at best a phone call or other very limited assistance.

Most people who have a low income also have other challenges in their lives. They face eviction and foreclosure; they face problems accessing healthcare or disability benefits or veteran's benefits. They need help with domestic violence protection orders; family law matters such as divorce, child custody, or child protection; immigration status; and employment and wage protection.

Violations of civil justice happen every day in America, and people without money have few avenues to do anything about it. The federal program to support legal services was developed when Richard Nixon was president;

### **The Constitution guarantees access to a lawyer when someone faces jeopardy and the loss of his or her liberty, but that guarantee, while beautiful, has not been delivered in practice. Many people around the country who face jail time have no lawyer at all.**

it had bipartisan commitment. In the last four years, however, its funding has declined by 20 percent. In real dollars we now spend less than a quarter of what we spent during the Nixon administration.

Nearly sixty legal services offices closed in the last year because of the declines in funding. In civil cases, there is no constitutional right to legal representation. Low-income individuals and often middle-class individuals have to represent themselves in court. Levels of this "self-representation" are at 80 or

90 percent in some areas of the country. Trial judges report that unrepresented litigants fail to present evidence, perform ineffective cross-examination, and make fatal errors in representing themselves; some estimate that such fatal errors by self-represented litigants arise in 60 percent of such cases.

Even if we didn't care about such unfairness as a matter of conscience, it turns out that failing to invest in civil justice is an expensive proposition. Lack of civil representation means rights go unenforced; delays and inefficiencies mar the entire system; and costs mount up for local communities. Not only is it the right thing to do; it is the smart thing to do because evidence shows that investing in access to legal assistance saves money.

Here in Massachusetts I served on a commission that demonstrated that for every one dollar spent on civil legal assistance the Commonwealth saves five. New York found that for every one dollar the state saves six dollars. How is this so?

The savings are realized in preventing homelessness, in securing federal disability or health benefits for which people are qualified, in helping people get child support orders enforced, in helping people pay their bills, avoid eviction, manage or prevent foster care placements. Prevention is cheaper than the consequences of not preventing terrible disasters for poor families.

Keeping a child with special needs in school, for example, can make all the difference in whether a parent can go to work.

### **Evidence shows that investing in access to legal assistance saves money.**

But if we don't actually pay to make sure the child gets the right placement, the family's finances can unwind.

One of the better federal programs developed to deal with civil legal assistance is in crisis because of the overall economy. The program – called IOLTA (Interest on Lawyers Trust Accounts) – is funded by the interest generated when lawyers hold a client's funds. If you have any idea of where interest rates have been lately, you will understand why this wonderful program has plummeted as a source of support.

We must look at new solutions. Possibilities include better leveraging of pro bono services by lawyers, including establishing partnerships with law firms, law schools, and companies. Perhaps most exciting are the prospects for technological innovation. Many courts are experimenting with the use of digital access to justice. This could include digital document assembly, mobile apps, or digital forms with an interactive AI (Artificial Intelligence) that individuals can consult as they pursue their claims. More profoundly, it could mean the use of business processes to address inefficiencies in people's access to justice. Fields like business, medicine, consumer relations, and even the drone industry have already leapt way ahead in the use of digital technology. These hold lessons for law.

Translation services are another great example. Access to justice for people whose primary language is not English is a critical problem. Artificial intelligence language translation can put the legal system within reach if we can figure out how to actually connect the individuals and maybe teach the programs some legal terms. The trans-



## Projects under Consideration

lation of “law-speak” into plain English for those who already speak English would also be a useful reform.

At our meeting at the Academy in November, we will examine the extent of the crisis. Our participants will include justices from state courts, as well as lawyers on the front lines and researchers. We will examine the pro bono and corporate lawyer contributions. We will also consider the potential for non-lawyers to provide legal services, even though that is somewhat of a “third rail” for the legal profession; it is something we have to think about given the scale of the challenges.

We will also examine reforms in the judicial system itself and will look at insights from the forty justice commissions that have been convened around the country. As we move forward, we have a dire need for data. Knowledge about how access to the justice system actually works is limited. And we cannot solve this problem until we improve that situation.

I have had the privilege of working in this field for a long time. I have also worked in post-conflict societies, and I can tell you that if you don’t have respect for the rule of law, if your society doesn’t have regard for fundamental fairness, you are setting up a world that is likely to lead, if not to civil war, at least to civil unrest. If you don’t have courts that can resolve disputes, you won’t have businesses that are willing to invest. If you don’t have a legal system that appears legitimate, you invite self-help, disputes, and violence.

Finally, rights are not self-enforcing. We have a superb Constitution, but it doesn’t mean anything unless it is enforced. By neglecting the issues surrounding access to justice, we are hollowing out the public good that is our legal system and the rule of law.

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### Diane P. Wood

*Diane P. Wood is the Chief Judge of the United States Court of Appeals for the Seventh Circuit and a Senior Lecturer at the University of Chicago Law School. She was elected a Fellow of the American Academy in 2004 and serves as the Chair of the Academy’s Council, Vice Chair of the Academy’s Board of Directors, and as a member of the Academy’s Trust.*

How is the Academy’s longer-term horizon defined? By what process do we choose the projects and studies that move forward?

This is the job of the Academy’s Council. We are advised by a Committee on Studies and Publications that examines each proposal in detail, thinks about what to do to bring it into focus, and considers whether it has the prospect of being a good study for the Academy. The Board of Directors, in order to make this a more transparent process, has approved a set of considerations that we think capture well what informs the selection of projects and studies.

Recently the Council has been discussing an initiative that would seek to enhance our understanding of the new nuclear age in

which we live, building on the Global Nuclear Future Initiative. The purpose of this project would be to see whether the current nuclear age differs from previous ones and, if so, how. How has technological innovation changed things? How should we be thinking about nuclear arsenals as opposed to conventional arsenals? How might the mounting geopolitical rivalries among states with nuclear weapons affect the sustainability and stability of our global nuclear order?

Another principal mission of the Academy is the study of American institutions. What makes us a functioning democracy? How do we educate citizens? How should we think about preparing citizens for the future? What do we mean when we talk about education? Have we educated people if they are competent in mathematics and they know how to read, or do we need to include civic education of some kind – history and other things that make an informed and active citizen?

These and similar questions have led us to consider a new project on the education of the American citizen, one that would draw on the work we have been doing in the sciences, social sciences, and humanities. The idea has not yet crystallized into a project, but it is something that will give you a glimpse of how we look at the medium- to longer-term horizon.

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## *Impact of Academy Projects*



### **Alan M. Dachs**

*Alan M. Dachs is President and Chief Executive Officer of Fremont Group, a San Francisco-based investment firm. He was elected a Fellow of the American Academy in 2007 and serves as Chair of the Academy's Trust and Vice Chair of the Academy's Board of Directors.*

“**N**ot everything that counts can be counted, and not everything that can be counted, counts.” As someone who makes his living in commerce and who is measured almost every day, I offer this quotation, attributed to Albert Einstein, to put at ease those who are engaged in more intellectual pursuits.

I am fairly broad minded about what constitutes impact. I would argue, for example, that everything the Academy does has impact. If a couple of us are sitting around a table, perhaps listening to a poem or engaged in conversation about the human condition, that has impact on an individual basis at least. It may bring joy or concern or inspiration, and that, in my view, is impact.

At the other end of the spectrum we get much closer to my daily experiences: how do you measure impact, and what do you

**As we go forward and think about what constitutes impact and how to measure it, we should never become so confident in ourselves as to forget that things that can't be measured also count.**

do with it once you have decided you have something that can actually make a difference in the world on a broader basis? These are questions we are trying to answer.

Many of the Academy's projects that you heard about today contemplate the transfer of knowledge and research into the public domain with the goal of changing behavior. Many of the Academy's commissions have also been working for a number of years, so it may take more than a month, more than a year, maybe more than three years for us to realize the full impact of what we do here.

The Academy has three governing bodies: the Board of Directors; the Council, which is concerned with the Academy's intellectual pursuits; and the Trust, which has been assigned the task of measuring or determining impact. My hope, and I think it is shared by my colleagues, is that we don't think of these as three separate organizations. The Council and the Trust should be interwoven at some level so that they can inform one another's work in a way that makes it much more interesting and gives it a greater chance for impact.

But as we go forward and think about what constitutes impact and how to measure it, we should never become so confident in ourselves as to forget that things that can't be measured also count. ■

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# Humanities Indicators Tracking the Field

Over the past year, the Humanities Indicators of the American Academy (<http://humanitiesindicators.org>) have been offering evidence for many of the urgent questions facing the humanities field. The Indicators encompass humanistic activities from early in life (parents reading to children, education in the schools) through college and on to encounters with the humanities later in life.

## Humanities in the Education System

As a field, the humanities rely heavily on a strong foundation in reading and basic language skills developed at an early age, but recent releases of the Indicators show a number of disturbing patterns in youths reading for fun and scoring on national and international tests. For instance:

- The share of 17-year-olds who reported never or rarely reading books had grown larger than the share who read almost every day.
- A declining share of K-12 humanities teachers are fully qualified (by education and certification) to teach English, history, and foreign language subjects. As of 2012, a substantial portion of public high school students in humanities subjects were being taught by someone who lacked either certification or a degree in the subject they were teaching.

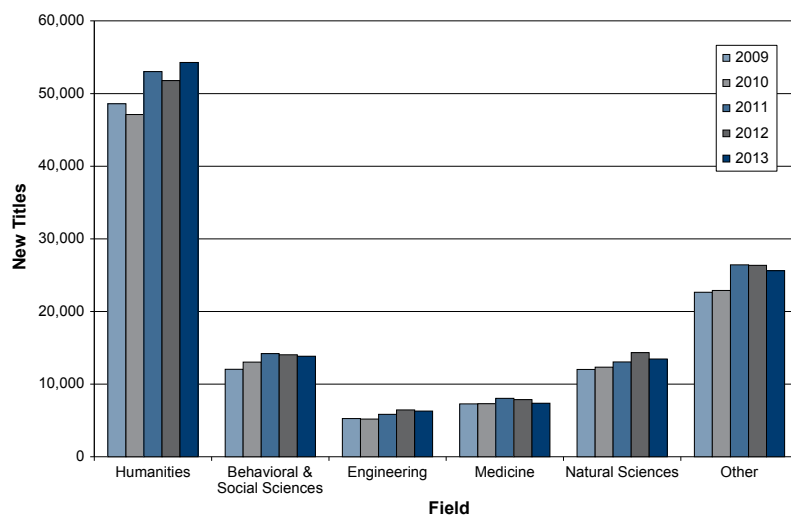
- The share of juniors and seniors expressing an interest in majoring in the humanities has been falling in recent years. In a discussion on the Academy's Data Forum (available at <http://www.amacad.org/DataForum>), Chandra L. Muller and Jamie M. Carroll (Department of Sociology and Population Research Center, University of Texas at Austin) found that while students have been indicating declining interest in the humanities before they begin their studies, when the same question is asked of first-year students in college, there appeared to be an increase in the share.

## Earnings and Occupations of Humanities Majors

There has been considerable speculation in the media over the past two years that college students are retreating from the humanities due to post-collegiate earnings. To address this claim, the Indicators published original research on Census Bureau data showing that while humanities majors often lag behind graduates from other fields in earnings, with additional experience and study, humanities majors generally gain on graduates from other fields. Among the other key findings:

- In 2013, the median annual earnings for undergraduate humanities majors were \$50,000 for those who held only a bachelor's degree and \$71,000 for those who had earned an advanced degree (in any field). Both amounts are \$7,000 below the median for graduates from all fields with similar degrees.
- The salary differential between humanities majors and graduates from other fields generally narrowed with experience. When the median salaries of younger workers (ages 24 to 34) are compared to those with more experience (ages 35 to 54), the gap in median salaries between the humanities and graduates from all fields narrowed by about two percentage points for those who hold only a bachelor's degree (declining

New North American Academic Books, by Field, 2009 – 2013



Source and details at <http://humanitiesindicators.org>.

from 11.1 percent to 9.1 percent) and those who had earned advanced degrees (falling from 12.3 percent to 10.5 percent).

- A comparatively large share of humanities graduates go into education-related occupations – especially among those with terminal bachelor’s degrees, where the humanities are second only to education majors. But among the 42 percent of undergraduate humanities majors who had gone on to earn an advanced degree, workers were more evenly distributed across occupational categories than majors in most of the other fields.

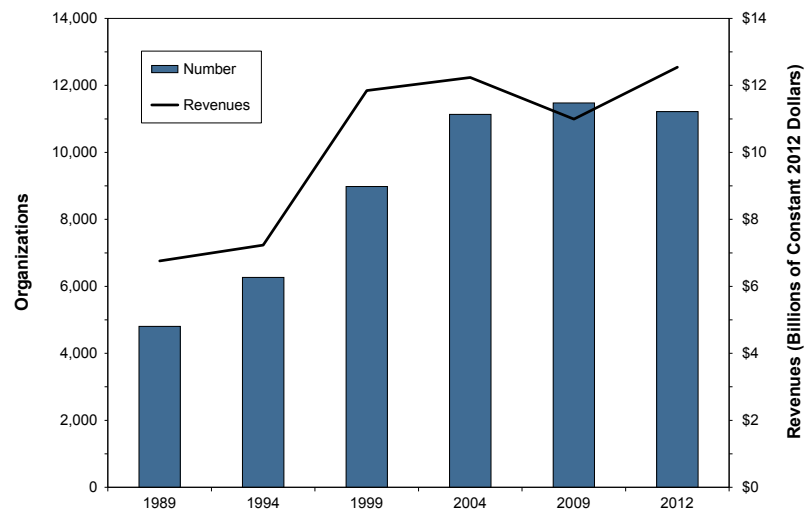
Christine Hensler (Professor and Chair of Modern Languages and Literatures, Union College) offered an assessment of the new numbers in the Academy’s Data Forum, surveying the values that are left out of an analysis of the economic outcomes of college graduates. She argued that “We have a social responsibility to reshape what really counts among all the counting.”

### Original Research on the Health of the Field

Alongside the general questions about the health of the humanities in American life, the Indicators have also published original analyses on such topics as interdisciplinary scholarship and the relationship between funding and the time it takes to earn a PhD. Among the key findings:

- Median time to a PhD in the humanities was at least a year longer than the life and physical sciences. And in every field, PhDs who relied primarily on personal or employer funding had the longest time to degree.
- A growing share of recent PhDs say their work is interdisciplinary, but over 70 percent of the graduates that described their dissertations this way worked in two or more disciplines within the same broad field of study (e.g., a humanities PhD will draw on history and philosophy, or a life sciences PhD will report molecular biology and medicine as his or her primary and secondary fields).

Numbers and Inflation-Adjusted Revenues of Not-for-Profit (NFP) Humanities Organizations, 1989 – 2012



Source and details at <http://humanitiesindicators.org>.

- Total revenues of the humanities not-for-profit sector have largely recovered from the recession, but the number of organizations declined, indicating that not all of them survived the economic downturn. As of 2012, humanities not-for-profits had combined revenues of over \$12.5 billion (accounting for 0.08 percent of the revenues reported for all IRS-designated 501(c)(3) public charities).
- 54,273 new academic humanities titles appeared in 2013, accounting for almost half of all academic books published. While the number of humanities titles had increased over the previous year, the number of titles published in most of the other academic fields declined slightly.

In the coming year, the Indicators will be producing additional research on education in languages other than English, trends in the number of degrees earned in humanities disciplines and public engagement with humanities institutions, as well as the employment patterns of those with graduate degrees in the humanities.

For more information about the Humanities Indicators, please visit the Academy’s website. ■

# The Evolving Role of Technology in Higher Education

On September 17, 2015, at the Silver Center of Arts and Science at New York University, **Matthew S. Santirocco** (Professor of Classics, Angelo J. Ranieri Director of Ancient Studies, and Senior Vice Provost for Academic Affairs at New York University) moderated a panel discussion featuring **Kevin Guthrie** (President and Co-Founder of ITHAKA), **Daphne Koller** (President and Co-Founder of Coursera, Inc., and formerly the Rajeev Motwani Professor of Computer Science at Stanford University), and **Nicholas Lemann** (Henry R. Luce Professor of Journalism and Dean Emeritus of the Columbia University Graduate School of Journalism). The program, which served as the Academy's 2022nd Stated Meeting, included a welcome from **John Sexton** (then President of New York University) and **Jonathan F. Fanton** (President of the American Academy of Arts and Sciences). The following is an edited transcript of the discussion.



## Matthew S. Santirocco

*Matthew S. Santirocco is Professor of Classics, Angelo J. Ranieri Director of Ancient Studies, and Senior Vice Provost for Academic Affairs at New York University. He was elected a Fellow of the American Academy in 2009.*

Several years ago, when I first became engaged in thinking deeply about technology-enhanced education, I was often asked by faculty colleagues – a number of whom I see in this room today – a question I had asked myself when I assumed this provostial assignment: *Why all the sudden interest in technology?*

**There is now increasing recognition that technology has a potential impact on all aspects of what we do – not just our scholarly research but also our teaching and mentoring, and not just graduate and professional training but also undergraduate education in the liberal arts.**

Of course, at one level, there is nothing “sudden” about the use of technology as an adjunct to learning. New York University (NYU), for example, can claim to have been, at one time, a pioneer in this space: from 1957 to 1982, it partnered with CBS to produce the Emmy Award–winning “Sunrise Semester,” a series of televised lecture courses. Viewed for free or taken for credit for a modest fee, these courses were a pre-digital forerunner of today’s MOOCs (Massive Open Online Courses).

More recently, NYU has offered a variety of online and blended programs, mostly, though not exclusively, at the graduate, professional, and executive education levels. These include: a Masters in Taxation at the Law School; a Masters in Engineering, which annually places in the top ten of online programs in this field nationally; and the creative use of simulations and adaptive learning techniques to rethink the delivery of education in the health professions – to name just a few examples.

Still, despite this historical and current level of engagement, my faculty colleagues were right: there is indeed something new – urgent, even – about our present preoccupation with technology. For better or for worse, the current conversation about technology has been implicated within a broader political discourse on higher education that focuses on the burgeoning costs of attending college, high student debt levels, and faltering job prospects; this is all in an economy in which technology is a negative disruptor for many industries. Will higher education be next? Or will technology save us, increasing access, enhancing efficiencies, and reducing costs?

Even more important – putting these odious financial concerns aside – there is now increasing recognition that technology has a potential impact on all aspects of what we do – not just our scholarly research but also our teaching and mentoring, and not just graduate and professional training but also undergraduate education in the liberal



arts. In particular, we are coming to understand that technology is not just an adjunct to learning along this continuum, but that it can actually transform how learning takes place, blurring the distinction between didactic instruction and learning through research, and between the dissemination of knowledge and its production. This could potentially alter the roles of faculty and students in ways that might be unsettling or, conversely, deeply empowering for both.

I want to take this opportunity to recognize the important role that institutional leaders can play in catalyzing constructive conversation and productive action in this space. NYU's president and provost, for example, charged a blue-ribbon faculty committee to explore the future of technology-enhanced education; by doing this, they signaled not only the importance of the topic, but also that strategic thinking in this area should be guided by our faculty. The committee focused on how technol-

ogy has, for example, focused our attention on teaching and learning in all settings, including face-to-face, with greater intensity. It is raising important questions of assessment and research. It has contributed to a robust discussion of the larger goals of higher education, at a time when the value of a degree is being questioned or – even worse – crudely assessed in terms of an economic return on investment. And so the evolving role of technology is the topic of our discussion today.

in New York, Abu Dhabi, and Shanghai – as well as eleven other academic centers around the world. In short, the relationship between in-person and online education, between “bricks and clicks,” had a particular relevance to our community.

The committee's report, which the university leadership accepted, embraced experimentation along the entire educational continuum, from in-person classes, to flipped and blended courses, to wholly online offerings. Further, taking into account our institution's organizational complexity, the report advised that one size does not, in fact, fit all; that schools and programs be empowered to experiment; that these experiments be rigorously assessed; and, finally, that the results of this research be disseminated widely. Since the report was issued just a year ago, interest in this area has grown exponentially in all of our schools and on all of our campuses. Significant investment has followed.

gy has, for example, focused our attention on teaching and learning in all settings, including face-to-face, with greater intensity. It is raising important questions of assessment and research. It has contributed to a robust discussion of the larger goals of higher education, at a time when the value of a degree is being questioned or – even worse – crudely assessed in terms of an economic return on investment. And so the evolving role of technology is the topic of our discussion today.

**We are coming to understand that technology is not just an adjunct to learning along this continuum, but that it can actually transform how learning takes place, blurring the distinction between didactic instruction and learning through research, and between the dissemination of knowledge and its production.**

ogy might help achieve a variety of school and university goals, from improving teaching and learning, our paramount goal, to expanding access, mitigating risk, and even enhancing revenue. It also focused on one other goal specific to our institution: how technology might promote the circulation of students, faculty, and ideas throughout a far-flung but interconnected global network that consists of three portal campuses –

From our local experience, one thing is certain: technology is here to stay. Equally certain, however, is that technology is evolving and that we cannot say exactly where it will lead, both within the traditional university setting and in other, nontraditional academic settings. While it remains to be seen whether the use of technology can produce efficiencies (and to what extent), we are starting to see other benefits. Technolo-



## Nicholas Lemann

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Though I lead a kind of double life as both a journalist and an academic, I hope that I might be able to set the stage by speaking primarily from my role as a journalist. I would first like to suggest an answer to Matthew’s question of *why* technology is such an enormously popular topic right now. Kathryn Schulz, a colleague of mine, wrote a wonderful book exploring epistemology entitled *Being Wrong* (2010), in which she argues that human beings are unfortunately addicted to inductive reasoning. This addiction is part of the problem here, particularly for my journalistic colleagues.

To clarify: let us consider today Sebastian Thrun’s Massive Open Online Course (MOOC) in computer science, which he offered at Stanford during the 2011–2012 academic year. The course had around 160,000 students sign up from around the world. Many of my colleagues in the press leapt on

### Can technology help elevate the importance of teaching in the university environment?

the event; let me take care here to differentiate between the education press, which tends to do a better job of being more tempered, and the elite opinion press, which typically flits from subject to subject in an overexcited fashion. Around the same time, we were seeing the incredible, sudden rise of a series of big Internet-based companies, including Amazon, Google, and Facebook. Very quickly, these companies built massive audiences and extremely dominant and unshakeable market positions.

As a group, we journalists all wondered, *which field will be next to be disrupted?* Universities seemed to be a distinct possibility. There is already much hyperbolic rhetoric around the Internet as it is. Further, an overwhelming number of stakeholders in business have an inherent interest in promoting such inflated rhetoric. In part because of these factors, a hasty narrative emerged, alongside a premature conclusion about the role of MOOCs.

These issues, as Matthew pointed out, form only a tiny subset of what we are here to talk about: the intersection of technology and education. Technology was always slated to be the “big disrupter” in higher education. You may have heard this catchism before: Higher education is the only institution in our society that hasn’t changed at all since medieval times. There is incredible inefficiency and emphasis on replication in processes. Economist William Baumol’s service paradox is at work here. Consider how tuition costs are rising, and how academics and graduates cannot get the jobs they were trained for. Compound this with nearly \$1.2 trillion of

student debt, and technological upheaval seems like a natural solution.

If I can extend this speculation in its most perfervid form: in the future, there will be a radically smaller number of higher education institutions that will be truly global, and the rest will disappear. This change will happen in tsunami-like fashion. I am sure that everybody in this audience has had some conversation at a party or at Thanksgiving dinner during which someone who is not a university employee flings this speculation at you, forcing you to respond, perhaps not patiently. I think the fever has died down recently, but at the time, the speculation ignored a number of important factors.

First, when the panic began, there was already a pre-existing world of online education. There was a disconnect between the speculation over effects of the “new” MOOCs and the real world of online education. Institutions like University of Phoenix and University of Maryland, Baltimore

### Can a synchronous online class feel like an intimate seminar, without interruptions?

County, along with other big purveyors, had already introduced much of the promise and opportunity that came to be associated with MOOCs. These online universities hosted small-format classes, led by people who were not academic superstars, teaching skills to people who were a long way away from most institutions of higher learning. For example, many military service members who were abroad in Iraq and Afghanistan were taking online courses through these universities. And you may even know some of these tireless instructors, who go

home at night after work to grade the papers of their online students.

But MOOCs were supposed to be distinct and revolutionary; a superstar thinker like Michael Sandel could give his popular Harvard course “Justice” to a person living in a village in Kashmir with an Internet connection. This is a wonderful opportunity.

versity environment? Can a synchronous online class feel like an intimate seminar, without interruptions? Finally, without a crack team of brilliant Stanford coders, and little ability to customize or modify an online hybrid course at the individual, school, or university level, what will it take for an online course to become truly successful?

### **What will it take for an online course to become truly successful?**

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The model involved the top academics in a field producing curriculum material that was mass-distributed. Meanwhile, the direct contact with students was completed by lesser mortals – unknown academics and teachers – who would meet with their students personally in smaller groups. But this describes the old world of textbooks, lectures, and discussion sections, as well as the new world of MOOCs. So, the suggestion that everybody suddenly for the first time in history had direct access to the thoughts of the topmost people in the academy simply isn’t true.

Ultimately, this conversation leads to a series of related economic and political questions in higher education: Do you like the status quo and want to preserve it? Do you see change as threatening? Do you believe in research universities, or do you believe research universities, including tenure, academic freedom, and nonskills courses, should not exist, and that this tech revolution can be a sort of pretext for getting rid of them? But I propose this discussion is not very useful for our purposes today. Instead, as a teacher, what I find most interesting – and what I most want to hear about from my colleagues – is how developments in technology might improve teaching and learning. Can technology help elevate the importance of teaching in the uni-



**Kevin Guthrie**

*Kevin Guthrie is President and Co-Founder of ITHAKA.*

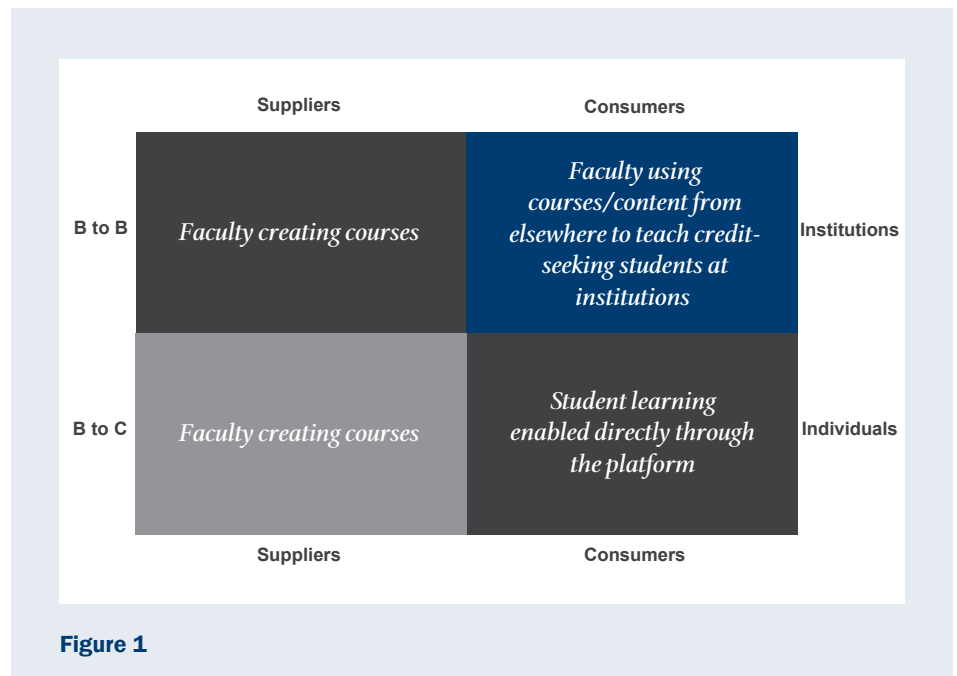
I always feel quite a bit of trepidation on panels such as this one, when I sit alongside distinguished academics. I am not a professor, and in that sense I am an outsider, but I have spent twenty years working at the intersection of technology and higher education. I was fortunate enough to help co-found JSTOR with Bill Bowen. Currently, in my role at ITHAKA, I help realize our mission, which is to address exactly some of the issues that Matthew just raised. For one, how can we help support education and have it be more accessible to more people at lower cost? (This was the original founding mission for JSTOR.) At ITHAKA, we offer three services: JSTOR, the digital library, forms the operating enterprise. We also deliver Ithaka S+R, an area of research and advisory services focused on issues of online learning and the evolution of technology’s impact, both on scholarly communications and on teaching and learning. Finally, Portico is a community-based digital archive.

**How does a particular group of institutions use these new technologies to improve their ability to deliver teaching and learning, and hopefully at higher quality and lower cost?**

My remarks today are sourced from studies completed at Ithaka S+R, including a randomized control trial that compared learning outcomes in a hybrid course with face-to-face learning. I am going to highlight some of the outcomes from a more recent study we did in collaboration with Coursera through the University of Maryland system.

First, however, I am going to talk a bit about markets, since many of the forces described by Matthew revolve around costs and cost recovery. I also want to ground my remarks in some definitions, since with new innovations come new terms – like MOOCs or *online learning* – that have different definitions for different people. In light

of this, a crystal-clear definition of context strikes me as quite important. Let us distinguish between several “markets” for online course delivery, defined by the nature of the suppliers and users. To illustrate, a MOOC like Coursera is a direct-to-consumer offering, or a “B to C” offering, because the institution or professor creates an online course on a learning platform that is then delivered directly to students all over the planet. The other market would be made up of services provided by one institution to another – business to business, or B-to-B – to use the commercial vernacular. In this context, that would be a situation where a professor affiliated with an institution creates an online



**Figure 1**

course on an online learning platform that is delivered through another institution to registered students.

I offer these two marketplaces as illustrative context for this discussion because the behaviors and outcomes differ depending on the approach. For example, there has been considerable discussion and criticism of MOOCs because of their low completion rates. But completion rates have an entirely different meaning in an institutional business-to-business context than in a direct-to-consumer offering. Whether students finish courses matters far more for registered students paying tuition at a university than for individual students taking a course online for free over the web. For the purposes of this discussion, I am going to focus on how technology can be used within an institutional learning environment. Figure 1 shows a simple representation of these marketplaces, which are defined by who are the suppliers and who are the consumers, and whether they are individuals or institutions. The first thing to note is that most of the initial attention has been focused on the supply side – the left side of the diagram. Professors love the idea of being the instructor for thousands or hundreds of thousands of students. And institutions, by joining Coursera or edX, have rushed to become the providers of courses used by students all over the world. On the right side of the table – the demand or consumption side – nearly all of the attention has been focused on serving individual unaffiliated students, represented by the lower right quadrant. The area of focus for my remarks is the blue box, where *institutions* are using technology or tools created elsewhere to teach registered students, either on campus or online.

As ITHAKA's mission is about helping higher education make a transition with technology, I am focused on the institutional context. How does a particular group of institutions use these new technologies to

improve their ability to deliver teaching and learning, and hopefully at higher quality and lower cost? There has been a variety of studies in this field, but we need more data on the learning outcomes associated with online learning and technology tools on campus. We have hosted – with Bill Bowen's lead – a rigorous, randomized control trial of a statistics course on a number of public university campuses.<sup>1</sup> Other studies have shown that there has been no difference between the learning outcomes delivered in a hybrid environment versus those delivered in a face-to-face environment. To be clear, there are studies – including rigorous, academic studies – that have produced different results. In sum, the research has not been conclusive, but significantly, there are examples in which the use of technology online in the classroom has delivered equivalent or better learning outcomes.

### **There are a number of important challenges in the institutional context that must be overcome if institutions are to take full advantage of new learning technologies to improve learning outcomes and/or lower costs.**

In one study, we enlisted faculty volunteers in the University of Maryland system to teach courses on the Coursera platform. They could teach the entire course or choose to take a segment of the course and teach it on campus. The study was designed to measure both impact on learning outcomes and impacts on cost of using externally developed courseware in hybrid courses. Was it possible for faculty to use on their own campus tools and content that were built

and developed elsewhere? What were the outcomes going to be like? The study was rigorous; in some ways it resembled a case study, in others it was more like a controlled trial. Generally, the learning outcomes were very similar between the two groups. Moreover, hybrid formats used less class time, because students were finishing much of the work online in between classes, which were, in turn, reserved for more focused interactive discussions. The implication, then, was that these classes would cost less to teach.

Generally speaking, the University of Maryland faculty who participated in the study were very enthusiastic about their experience teaching courses in this way. They enjoyed getting exposure to different perspectives from faculty teaching Coursera courses; the exposure allowed them to augment their experience, and gain flexibility in the use of face-to-face time with students.

Some of the faculty were eager to help students replace the costs of textbooks. Challenges were evident, as well. The Coursera course method wasn't always a good fit for how faculty wanted to teach students, or it didn't match the level of knowledge their students had. There were also technical problems, given that the technology was often difficult to incorporate into on-campus learning management systems (LMSS).

In sum, this study showed that there is reason to be optimistic that it is possible to improve learning outcomes while simultaneously addressing some of the cost issues at hand. Even if that is the case, however,

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1. <http://www.sr.ithaka.org/wp-content/uploads/2015/08/sr-ithaka-interactive-learning-online-at-public-universities.pdf>.



## FACULTY CONCERNS

- Potential reduction in the ranks
- Presumption that effective teaching requires close face-to-face interaction
- Preparing an online course is time-consuming and requires new skills
- Faculty want to “own” the courses they teach
- Faculty must be able to customize the student experience

Figure 2

when put together with other research Ithaca S+R has conducted, it is evident there are a number of important challenges in the institutional context that must be overcome if institutions are to take full advantage of new learning technologies to improve learning outcomes and/or lower costs. The challenges break down into those that can be addressed at individual institutions, and others that are likely to require cross-institutional coordination, or at least cooperation.

The first institutional challenge is, I would argue, an overblown notion, just one part of the broader discourse: the notion that faculty do not want change and are resistant to it for its own sake (see Figure 2). Although of course there are some faculty who want to keep doing things the way that is familiar to them, in our work we have found faculty are enthusiastic and want to use technology to teach their students better. The single greatest area of resistance among faculty is largely linked to a justifiable desire to provide a customized learning experience for their students. They need to be able to tailor platforms, content,

and teaching tools to work for their students and they want to own the course experience for them. Right now, many of the platforms don't provide this.

Another challenge that we found, through our studies and interviews of faculty, is how starkly different the view of higher education can be from different perspectives. Consider the views of research universities and elite colleges on the “business of the institution,” versus the views of parents or legislators. The former may believe the institution's main role is knowledge creation; the latter will claim that the primary role of the institution is teaching the next generation of students. This gap between how the institution sees itself from the inside and how important constituents regard the institutions from the outside makes finding common approaches difficult.

Governance presents another set of challenges. The rapid changes brought by new technologies complicate decision-making processes. For instance, technology favors scale, which shapes decisions about teaching context, decisions that used to be fun-

damentally or exclusively owned by faculty. Once an online teaching platform is introduced, those decisions move up from the faculty member to the department level, and then up to the college, university, and maybe even cross-university levels. Where these decisions were once easily handled individually by a faculty member in a face-to-face environment, in the context of new technology, they get stretched horizontally across traditional areas. This makes decision-making and coordination around these areas much more difficult. In a time of fast-moving change and evolution in higher education, the decision-making apparatus needs to be paced appropriately.

Through my observations and conversations with people about shared governance, tensions between faculty and administration seem to revolve mostly around a fundamental disagreement about the nature of the problems facing the institution, more than it is an argument about the best ways to address them. Is there in fact agreement that we need to develop less expensive ways to deliver high-quality education? Rarely will you hear a faculty member say, “I'm trying to figure out how to implement my course so that I can both improve learning outcomes for our students and reduce the costs associated with delivery.” My point here is not to criticize this position; it is simply to observe that it is the case. Faculty are not expected to think about ways to do their jobs “more efficiently.” In fact, they are purposely protected from having to consider such matters. If we need to identify more cost-effective ways to deliver instruction, we are going to have to engage our faculty to develop those approaches. The answer is not to get rid of faculty; the answer is to help and support the faculty to use technology both to improve and lower the costs of instruction and learning.

When thinking about the potential for reducing costs, one cannot avoid the reality that many aspects of the infrastructure

### **If we need to identify more cost-effective ways to deliver instruction, we are going to have to engage our faculty to develop those approaches. The answer is not to get rid of faculty; the answer is to use the technology and the faculty more effectively.**

at higher education institutions are either fixed, or profoundly inflexible. Even if opportunities for reduced faculty instructional time can be found, it is quite difficult to realize those savings in static institutional environments. So much is already invested in the infrastructure. The calendar is established. Students accumulate credits. Faculty teach a measured number of credit hours. These realities reduce the ability of the institution to realize the savings, because so many of the costs are either fixed or seem immovable.

Beyond these internal institutional questions, there are cross institutional issues to consider as well. One important area relates to data and privacy. The trail of data that is left by students working in online learning platforms provides an opportunity for continuous improvement; the data can be used to inform and update the systems. Commercial learning platform providers are collecting these data and will use those data, just as Google uses search data, to improve the systems that support instruction. Any enterprise working on the web will be harnessing and collecting data and analyzing it to get better at providing their particular service. An institution that achieves scale in this environment, as MOOCs are attempting to do, has an enormous amount of data with which to improve that system.

One thousand individual higher education institutions, all collecting data on each of their individual sets of students, will not have access to sufficient data to improve systems at rates comparable to an enterprise that has access to geographical data. It could

prove to be increasingly difficult for these institutions to provide learning outcomes that are comparable with such systems. It may therefore be necessary for institutions to share anonymized student data or develop other ways to ensure that systems can be improved based on feedback from learners. Protecting student data privacy will be a key issue here. Universities and colleges will be appropriately cautious about the privacy issues around student data. They will move slowly – compared to commercial firms – in their willingness to use data to improve systems. Frankly, institutions whose core mission involves improving learning outcomes are at a disadvantage if they are not moving quickly to use those data.

A final issue/cross-institutional barrier I would like to address is intellectual property. Who owns the online course once it is created? If a course has been created at one institution, can the faculty member who created it leave and take it to another institution? The faculty member has done most, if not all, of the intellectual work and content creation, but he or she may not have been able to build the course without support from the institution and its instructional technologists for the platform. Does the faculty member own it, or does the institution? Does the platform provider who created the platform own it? This is important not just from the standpoint of payment; this is also an issue of control and persistence. If I am a faculty member at an institution and I want to use technology tools or content created elsewhere, I have to make

an investment to use these materials in my course. But first, I need to be assured that these materials will be available in subsequent semesters.

I hope you won't mind if I provide an historical anecdote to illustrate the importance of this kind of sustainability. Back in 1995, in the early days of JSTOR, there were no license agreements to govern the environment about how people could use a book or a journal. There were copyright laws in place, but the delivery of content in physical form was largely untethered. You purchased a book, or a journal, you took delivery of it and you owned it. You took responsibility and assumed the costs for its care, but you also were able to use it in whatever ways you wanted (subject to copyright law). Today, an electronic version of a book or journal is connected to the network. A content provider could turn off access at any moment, and in that instant all readers would no longer have access. Since our access to material suddenly depended largely on the institution's choices, a whole licensing infrastructure for content had to be built to govern those relationships and ensure reasonable and persistent access and availability of the content.

Nothing like this infrastructure or rule book exists for teaching and learning online. We are in a Wild West environment in which both rules and the ownership of teaching content are unclear. This is yet another reason why it will take time and effort to help these technologies take off within institutions. So it is not just resistance from faculty, or fear of new technologies, that stands in the way of wide acceptance of new forms of instruction. There are a number of important practical institutional and cross-institutional challenges that need to be overcome for these learning technologies to thrive and reach their full potential.

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## Daphne Koller

*Daphne Koller is President and Co-Founder of Coursera, Inc., and was formerly the Rajeev Motwani Professor of Computer Science at Stanford University. She was elected a Fellow of the American Academy in 2014.*

I will be focusing on the one part of the picture that my esteemed colleagues did not talk about, which is the direct-to-consumer aspect of online courses. Our vision at Coursera, which we established in early 2012, is a world in which anyone, anywhere, can transform his or her life by accessing the world's best learning experience. Today, I would like to highlight a number of discrete aspects of this vision statement.

Perhaps one of the most important aspects is the "anyone, anywhere" phrase: this is the *access component* of what we are trying to accomplish. If we are speaking from institutions like Stanford, or Columbia, or NYU, we serve a very privileged minority of people who have this amazing opportunity to go and study with some of the world's best scholars. There are a great many people all over the world who will never have access to anything remotely comparable to that

## Our vision at Coursera is a world in which anyone, anywhere, can transform his or her life by accessing the world's best learning experience.

kind of opportunity. These are people who are, currently, non-consumers of education, many of whom would benefit tremendously from this potentially transformative experience. At Coursera, we are trying to come up with a way to provide not the exact same opportunity that a Stanford or an NYU student would have, but at least something that nonetheless might have potentially transformative effects.

Coursera launched in 2012 following the (aforementioned) Sebastian Thrun-led MOOC as well as two other Stanford MOOCs, in machine learning and in databases, released at about the same time. This catalyzed the Gartner hype cycle<sup>2</sup> around MOOCs; as *The New York Times* announced: 2012 "was the year of the MOOC." We were supposedly going to completely disrupt education. Somehow a narrative emerged – that in fifty years there will be ten universities total – that we neither espoused nor supported. Then came 2013, and people realized that a year had passed, and yet universities were still in business! The next unfounded conclusion was that MOOCs must have failed.

Right now we are gradually gaining an understanding what these courses can and cannot do, including their impact outside of the university setting. When Coursera started, we had four university partners, thirty-seven courses, and two hundred thousand learners left over from the Stanford courses held in the fall of 2011. Today, we have 127 partners on six continents, offering courses in ten different languages. Through our selection of nearly 1,300 courses, we are

offering an education to over fifteen million learners in every single country around the world. We have registered over two million course completions, with learners watching over 13,500 years of video. Our university partners include top private as well as public institutions, both in the United States and abroad: for example, Yale, Princeton, Columbia, Stanford, Michigan, Washington, and Virginia as well as top institutions in many countries, including Switzerland, China, Singapore, Taiwan, Australia, France, Korea, and Germany.

Who are the learners that we serve? For one, only 30 percent of our learners are in the United States and Canada; 9 percent are in Latin America, 27 percent each in Europe and Asia, and 4 percent in Africa. We have learners in every single country around the world, including North Korea: a few months ago we discovered some enterprising North Korean learners who have somehow accessed the platform despite state censorship and limits on Internet use. Another point of pride for us at Coursera is that between 38 and 40 percent of our learners come from emerging economies.

Our learners are about 40 percent male and 60 percent female, though this split varies a lot by country. In the United States, the split is about 40/60, whereas Scandinavian countries are split 50/50. India's learner demographics skew toward the male. The twenty-five- to thirty-five-year-old age group forms, by far, the biggest node of the distribution. Our learners are not traditional college students. Most of them have finished whatever formal education they are likely to have, and they are likely never to go back to school again. Around 55 percent

2. For a brief explanation of the Gartner hype cycle, see [https://en.wikipedia.org/wiki/Hype\\_cycle](https://en.wikipedia.org/wiki/Hype_cycle).

of our learners are employed full-time, and those who are not represent a tremendous opportunity for service. Seventy-five percent of our learners have at least a bachelor's degree; 25 percent of our learners do not, and that 25 percent of fifteen million is still a very large number of people.

Next, let's discuss motivations, because this helps us understand our audience. We completed a learner's segmentation based largely on U.S. data. However, the same patterns carry through worldwide, with slightly different proportions. There is a group of learners looking to MOOCs as stepping stones toward a traditional educational experience; in taking a MOOC, they feel they will increase their chances of doing well in college. Worldwide, this percentage of learners sits at 28 percent. These are dis-

tributed among high school students who are looking to better prepare for college by learning what discipline they want to study, or by increasing their skills. The others are currently in college and are looking to supplement their education with high-quality offerings that might not be available at their current academic institution. This is particularly common in emerging economies like India and China, where the vast majority of students are not in top-notch academic institutions. A large subset of these learners is taking introductory STEM courses.

don't have a degree, but I have these certificates instead.”

The next subset of learners is the enrichment learners, who form 25 percent of our population in the United States. These are adults taking courses alongside their working lives. There is a peak in learners in their mid-thirties, and another peak around ages of fifty to seventy. These learners take courses that are all over the map: art history, astronomy, policy, governance, environmental science. They do it purely for the pleasure of learning.

The final, and by far the largest, group of learners that we have in every single country are the career skill-builders. They form over half (52 percent) of our learners. These are people who are working adults, or who want to be working adults. They are using these

courses to upgrade their skills and then, hopefully, rescale themselves within their jobs. The courses that they take are largely focused in three areas: business, technology, and data science. They also take health science and engineering courses. All these investments are career-motivated.

We recently surveyed our learners, and asked them if they were benefiting from the courses, and in what way. Users listed a whole range of different benefits. Tangible benefits include getting a promotion, finding a new job, and starting one's own business. There are then smaller, less tangible boons, like being better equipped for one's current job or improving one's candidacy for new job positions down the line. In terms of educational advantage, people report more abstract gains, including being able to finally decide one's field of study (a high school student, for example, can learn what it means to study psychology, before deciding if he or she wants to pursue this field in college). A significant fraction of learners say that they can walk into college with MOOC credits that allow them to waive prerequisites, which, I think, is a fine way to reward hard work done before college begins.

Since it is important to put faces to these stories and make them concrete, I am going to give two anecdotes about our learners; these are my favorites out of our repository of hundreds. The first is about Kehinde, who is from Lagos, Nigeria. Kehinde was one of the lucky ones in Lagos because he worked at IBM as an engineer, a good position that is not that easily obtained in Lagos. However, he wasn't very happy with it because he thought he could do more. He took courses with us on strategy, management, psychology, and entrepreneurship, and then made the very brave step of leaving his cushy job to found a startup. Based on what he learned, he was able to found the startup successfully. His company now employs ten people, full-time. Kehinde still has a problem in terms of hiring, because there are not a lot of qualified engineers in Lagos, given that the quality of the local education is rather mixed. He chooses to use these MOOCs to address his hiring and training needs, which is the only way, he says, he can develop talent on a low budget.

### **A point of pride for us at Coursera is that between 38 and 40 percent of our learners come from emerging economies.**

Despite the hyperbole about whether Coursera will substitute for traditional undergraduate education, we do not see people using Coursera in lieu of undergraduate degree work. We do not see people taking courses, accumulating piles of certificates, and showing up to an employer saying, “I

The other striking example I have is of Scotty from Alabama. No one in his family ever went to college. Scotty was a star student in high school and got a full scholarship to go to the University of Texas at Austin, but because no one in his family thought this was a good idea, he ended up declining the offer. He became a taxi driver instead, living paycheck to paycheck, barely making ends meet. One day, he was laid off, and he had no resources as a backup. Within a matter of months, he lost his home, his



wife, and eventually custody of his thirteen-year-old daughter because he had no place for her to sleep. He promised himself that if he ever emerged from that period of disaster, he would make sure that it would never happen again.

Eventually, he found a job as a horse groomer. When he got back on his feet, he Googled *free college credit*. We don't provide free college credit, but Coursera nonetheless came up in his search. He started taking courses because he wanted to gain confidence in his push to go to college. He took a number of courses, and ended up doing really well. This inspired him to make a successful application to college. He is now an English major at Arizona State University and the first person in his family to attend college. At the age of forty-five, he is back in school, and was recently inducted into the honor society.

I hope these anecdotes give a sense of the people that our technology can reach. How do we best help these learners, particularly the career-oriented ones? These are the 52 percent of people who need focused job skills to help them move forward in life. We created specializations that offer learners a focused skill – whether in data science or business foundations from Wharton, or digital marketing from the University of Illinois – to gain a rung in their careers. These skills are practical, valuable credentials in the workplace. We are hearing that 75 percent of employers say that they will consider the completion of MOOCs in their hiring decisions; when learners post these credentials on LinkedIn, recruiters start calling them. If you look at the National Security Agency (NSA) site listing for the data scientist position, completing the Johns Hopkins data science specialization through our MOOC is one of the entry criteria that they accept for that position. In response to a demand for data scientists, the Singaporean government, one of the world's most for-

## Despite the hyperbole about whether Coursera will substitute for traditional undergraduate education, we do not see people using Coursera in lieu of undergraduate degree work.

ward-thinking governments from an educational perspective, chose to pay the certificate cost for anyone who completes the data science specialization. The government only pays for completion – not for learners who start the courses then decide to drop out. For the low price of \$800, the government can train a full-fledged, functional data scientist, and can recoup that \$800 from taxes on that data scientist's first paycheck. Malaysia has now followed suit.

These flexible micro-credentials that we are making available via these specializations can also be aggregated into larger units. We are running a fascinating experiment at the University of Illinois, which recently created the first “stackable” graduate degree. This means that the degree is disaggregated into specializations: you can complete one specialization or two, but if you complete six, and you satisfy the admissions criteria, you have earned an MBA degree. I particularly love this because part of the issue with degrees is that, in some cases, 90 percent of the degree is worth absolutely nothing in the marketplace, whereas each specialization has distinct value for a career. For instance, if you complete the digital marketing specialization, you can go and run Facebook campaigns. If you want a complete degree instead, you can work toward it, using digital marketing as one step. The specializations fit different needs for different people.

Most university presidents will tell you that the mission of their university is the creation and dissemination of knowledge. Most research universities do an absolutely phenomenal job with the creation of knowledge.

But in terms of the dissemination of knowledge, track records are more mixed. Certainly we disseminate knowledge by writing papers, which some people read; that increases the overall body of knowledge worldwide. However, the potential for dissemination of knowledge is so much greater than just teaching the few dozen or hundred people who show up to our on-campus classes. As we consider the compositions of the missions of our great universities, I believe we shouldn't just focus on the creation of knowledge, but also on maximizing the dissemination of knowledge so that people like Kehinde, Scotty, and many others can benefit from it.

As H. G. Wells once said, “History is a race between education and catastrophe.” The dissemination of truly great education is what humankind needs to win the race. ■

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# Scientific Advances and Their Impact on Society

On October 21, 2015, at the Sanford Consortium for Regenerative Medicine in La Jolla, California, Lawrence Goldstein (Distinguished Professor in the Department of Cellular and Molecular Medicine and the Department of Neurosciences at the University of California, San Diego School of Medicine; Director of the UC San Diego Stem Cell Program; Scientific Director of the Sanford Consortium for Regenerative Medicine; and Director of the Sanford Stem Cell Clinical Center) moderated a panel discussion about scientific advances and their impact on society with J. Craig Venter (Co-founder, Executive Chairman, and Chief Executive Officer of Human Longevity, Inc.), Lisa Madlensky (Associate Professor in the Department of Family Medicine and Public Health at the University of California, San Diego Medical Center and Program Director and Genetic Counselor at the Family Cancer Genetics Program at the Moores Cancer Center at the University of California, San Diego), and John H. Evans (Professor of Sociology and Associate Dean of the Division of Social Science at the University of California, San Diego). The program, which served as the Academy's 2026th Stated Meeting, included a welcome from Jonathan F. Fanton (President of the American Academy) and Gordon N. Gill (Professor of Medicine and of Cellular and Molecular Medicine Emeritus at the University of California, San Diego School of Medicine). The following is an edited transcript of the discussion.



## Lawrence Goldstein

*Lawrence Goldstein is Distinguished Professor in the Department of Cellular and Molecular Medicine and the Department of Neurosciences at the University of California, San Diego School of Medicine. He also serves as Director of the UC San Diego Stem Cell Program, as Scientific Director of the Sanford Consortium for Regenerative Medicine, and as Director of the Sanford Stem Cell Clinical Center. He was elected a Fellow of the American Academy in 2008.*

## How does the public understand new biomedical technologies, and how do laypeople form opinions about these new technologies, particularly when they are controversial?

Our topic is scientific advances and their impact on society. How does the public understand new biomedical technologies, and how do laypeople form opinions about these new technologies, particularly when they are controversial?

One area that has received a great deal of press recently is stem cells. This is obviously a new and very exciting area of biomedical technology. Stem cells have enormous plasticity when you grow them in the lab, and we are learning to convert them to cells that have been lost to or damaged by disease; for example, pancreatic cells in the case of diabetes, or certain kinds of brain cells in the case of Parkinson's disease. The hope is that in the coming years, if we can learn to do this efficiently, we can begin to treat these diseases and bring relief to the people who suffer from them.

The other major promise of stem cell technology – probably not so controversial – is to begin to build bits and pieces of organs to provide support at the early stages of organ failure. Eventually we will, I think, learn to make entire organs from stem cells if we learn how to build the appropriate plumbing.

What is sometimes not realized by the public is just how much hard work and time it takes to solve each of these technical problems. An idea that might take thirty seconds to draw on the blackboard can end up being a twenty-year project by the time it is done. The public does not always understand this “time problem,” and that sometimes plagues us as a field.

The other problem we tangle with in the stem cell area – one that has gotten recent play – is the source of the cells we use. Sometimes the cells we use come from frozen embryos left over after in vitro fertil-

**Stem cells have enormous plasticity when you grow them in the lab, and we are learning to convert them to cells that have been lost to or damaged by disease.**

ization. More recently you may have heard that fetal tissue is used by researchers such as myself in experiments and in potential therapies where no other option is available.

For example, we use fetal brain cells in my lab’s work on Alzheimer’s disease, and in the center I direct we are using fetal stem cells derived from the spinal cord in a phase I clinical trial to treat spinal cord injury. These are the types of stem cells that have recently become extremely controversial, often without a lot of understanding driving the controversy.

A third problem that we have been tangling with in recent years is what I refer to as “the snake oil problem.” Any new technology frequently has imitators on a street corner near you. And stem cells have this problem too. So-called stem cell snake oil clinics will isolate so-called stem cells from a variety of your organs – fat and bone marrow are the popular ones – and will claim to treat you with these cells for any disease that ails you: ALS, Alzheimer’s, you name it. If a clinical trial even vaguely resembles it, these clinics will try to sell you an unproven therapy, taking advantage of gray areas in FDA law and regulation.

Finally, we experience the sorts of “normal” problems that go along with any cutting-edge area of biomedical technology. The issue of cost, for example, and questions of who gets access. And what are the individual versus the group benefits of a given treatment?

One problem that is coming at us relatively quickly is the use of stem cells to make gametes: sperm cells and egg cells. Making them is relatively straightforward, or at least it will be in the coming years. Those cells

could then be genetically engineered to be resistant to disease or to give the organism enhancements. We are already seeing the tip of this iceberg as genetic technology is used to produce embryos that are resistant to, for example, mitochondrial diseases.



**J. Craig Venter**

*J. Craig Venter is a Cofounder, Executive Chairman, and CEO of Human Longevity, Inc., a privately held genomics and cell therapy-based diagnostic and therapeutic company focused on extending the healthy, high-performance human life span. He is also Founder, Executive Chairman, and CEO of the J. Craig Venter Institute and a Cofounder, Executive Chairman, and Co-Chief Scientist of Synthetic Genomics, Inc. He was elected a Fellow of the American Academy in 2001.*

My team sequenced the first human genome fifteen years ago and had the pleasure of announcing the achievement live on worldwide television with President Bill Clinton and Tony Blair. That genome cost \$100 million to sequence and took about nine months to do. Because it was the first, it was a huge challenge. Today, using new technology, we are sequencing 3,000 genomes a month, scaling up to over 10,000 a month.

So we are at a slightly different scale than fifteen years ago, when the first genome was considered such a gargantuan product that every university and every country had to

contribute to it. Sydney Brenner wanted to have prisoners sequence DNA because it was such an arduous task. Things got a whole lot simpler thanks to computers and a few good algorithms.

Just in the last few months here in La Jolla we have sequenced about 20,000 human genomes. We have the largest database of genome data, coupled with phenotype and clinical measurements. And it is already yielding fantastic breakthroughs. We have major programs in oncology, which is probably the area that is changing the fastest in medicine, based on genomic data, because we can find out precisely what has changed. Fortunately, we also have a number of novel approaches to deal with those changes.

So this is now getting to be a data-driven and science-driven aspect of medicine. The biggest challenge is changing the physicians. David Brenner and I are trying to start a program where every medical student at the University of California, San Diego will

**We have the largest database of genome data, coupled with phenotype and clinical measurements. And it is already yielding fantastic breakthroughs.**

the lowest premiums live eight years longer on average than the ones who pay the highest premiums and do not follow preventative health measures.

The future of genomics will be about detecting things early, preventing disease, or allowing – because of early detection – early treatment. Compare that to the way medicine is practiced now, where we wait until symptoms occur and then try to do something about them.

We just opened the Health Nucleus at Human Longevity. There you can get the most comprehensive physical analysis and examination with MRI imaging, 4-D echocardiogram, and CT imaging, allowing us to generate beautiful, comprehensive photo-

When I told the head of one major clinic in the United States about this, he said it was a heart surgeon's wet dream. You do not get a second chance to learn about aneurysms. Even if you are in the operating room at the time, the chances of recovery are low. But thanks to early detection, we found something that a simple procedure could correct, giving the patient a different experience going forward.

**Today, using new technology, we are sequencing 3,000 genomes a month, scaling up to over 10,000 a month.**

have their genome sequenced and will then have to analyze it. But at least a third of incoming medical students do not want to know. How can they be ambassadors for the rest of the community and explain to you and interpret your genome if they are afraid to look at their own?

We are also working with third-party payers, with insurance companies that want to use this data as preventative medicine. We announced a program with Discovery Health in South Africa and England, and they are now offering genome analysis to their 4.4 million members who use their Vitality health program of preventative medicine. Those who follow the program and pay

graphs of every part of your body, measure any changes, and link it all back to your genome, your microbiome, and thousands of chemicals. It is a great starting point.

One of the first to go through it was a physician in his forties. From just the 4-D echocardiogram we discovered a greatly distended aorta. His first symptom would have been sudden death. He is also a weightlifter and has hypertension. So the question was when, not if, he was going to have a blowout. The problem proved to be genetic. His father had the same disorder – it was corrected with surgery early on – but his doctors thought it was just an anomaly. They had no idea he had this condition.



## Lisa Madlensky

*Lisa Madlensky is Associate Professor in the Department of Family Medicine and Public Health at the University of California, San Diego Medical Center, and Program Director and Genetic Counselor at the Family Cancer Genetics Program at the Moores Cancer Center at the University of California, San Diego.*

**W**hat do these rapid advances in technology and genomics mean to the average person?

Every day I have the honor and privilege of meeting with people who are going through a diagnosis of cancer or who may have had a lot of cancer in their family, and their main question, the number one thing they want to know, is, “What does this mean for my kids?”

Historically, genetic counselors were primarily involved in prenatal genetic testing and pediatric genetic testing. Initially they helped families who had a newborn baby with a serious medical condition that either had not been diagnosed or needed a series of tests to come to a diagnosis. Once we got to the point where a lot of these primarily metabolic diseases were understood, then prenatal testing became an option for many families.

**Every family is unique in their experience, so we want to take all of this very complex medical information, complex genetic information, and make it work for each individual family.**

As genetic counselors, we are trained in two domains. One is molecular biology, genetics, and genomics. We have to know the subject matter in order to be able to explain it to people. The other area is counseling, in helping families navigate the information they receive. If you are not at an emotional place where you can actually hear what we are telling you, it is not going to sink in.

Every family is unique in their experience, so we want to take all of this very complex medical information, complex genetic information, and make it work for each individual family. That can mean things like respecting cultural preferences, since different cultures interpret genomic and genetic information differently. We also want to be respectful of people’s reproductive choices. So we present ourselves as neutral players.

But I can tell you about the experiences of the people who actually do choose to engage. And even among them, some eventually say, “You know what? I am not fully convinced that I want this information.”

So our job is to ensure that people are making informed choices. Our job is not to present an agenda, to say, “You should have this testing” or “You need this testing.” Instead our job is to say, “Look. Here is what this testing can tell you right now. If we find something in these genes or we find this particular diagnosis, here is how it would affect your medical care, and here is what it could mean for your family.”

The majority of people who make an appointment and choose to come in do ultimately choose the genetic testing. But in many cases we have to acknowledge that al-

**To be successful, we need to improve scientific literacy. We need to help people understand, from a very young age, what our genetic makeup is all about.**

We are there to help families get what they want to get out of the information.

We cannot help people who do not come in, though, and about one-third of patients who are referred for genetic counseling never make an appointment. Why? Maybe their insurance does not cover it. Or maybe they cannot get time off from work or coordinate childcare. Or maybe they are afraid of what they might learn.

They could have any number of reasons, and because I never meet these people I cannot tell you anything definite about them.

though we might have the technology to sequence a particular gene, to identify a mutation or a variant at such-and-such location, we do not yet know what that means.

I am very excited that in the future we will have that information, but we have to work in the present with the families that are coming in now. That means they are often very disappointed. For some, the promise of genetics and genomics has been overhyped, oversold, and we are not able to meet their expectations. Instead, all we can say is, “This sounds exciting. Come back in five or



ten years, and maybe we will have answers for you. But right now, I cannot tell you what to do about your medical care or what this means for your family.”

Other times people are delighted, enthusiastic about the opportunity to get a diagnosis that has escaped their family for years. We call this “ending the diagnostic odyssey.”

Ultimately, people choose to engage or not to engage for a wide range of reasons. I see patients from very poor and underserved communities, people with graduate degrees in genetics and genomics, and a lot of biotech executives. Everybody can learn something.

I would like to share an anecdote with you about one of my patients. She tested positive for breast cancer. Her mother’s side of the family had a lot of early onset breast cancer and ovarian cancer. So we knew where the cancer, genetically speaking, had come from. To us it was quite obvious. But my patient said, “There is no way I have this gene, because I look just like my dad. I know I have all of his genes.”

So we had to take a big step back, all the way to first principles, breaking down concepts and helping her integrate from scratch the fact that this really was real. But if you take another step back, you can see that her reaction – “This couldn’t possibly be me. I’m not going to believe that this is true.” – is also a coping mechanism. Our job is to put all of these pieces together in a way that helps people make health decisions that will work for them and will be appropriate for them.

But to be successful there, we really need to start with improving scientific literacy. We need to help people understand, from a very young age, what our genetic makeup is all about. What can it tell us? What can’t it tell us? Moving forward, that is going to be an important priority.

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### John H. Evans

*John H. Evans is Professor of Sociology and Associate Dean of the Division of Social Science at the University of California, San Diego.*

When developing surveys to identify how members of the public form opinions about controversial issues in the life sciences – such as embryonic stem cell research, germ line or somatic human genetic engineering, cloning, and gene editing – you use statistical procedures to ask, “What type of person is likely to be more or less opposed to these technologies?” Belonging to some groups turns out to have no particular effect on one’s disposition toward these technologies. Men and women, for example, have roughly the same attitudes toward all these technologies. People of different classes and races have basically the same views of these technologies.

What does matter is how much education a person has and what their exact religion is. By talking briefly about these two, I want to dispel some myths that exist in this area. I believe that if the scientific community were to focus on these myths, it could better understand the public on these issues.

**Surveys show that the more educated a person is, the more likely he or she is to support the sorts of new technologies scientists are interested in.**

Surveys show that the more educated a person is, the more likely he or she is to support the sorts of new technologies scientists are interested in. Why would this be? Three decades ago the answer would have been, “Well, people with more education are more intelligent, and following the scientist’s agenda is the more intelligent thing to do.” That is not taken as a serious argument anymore.

The more serious version of the argument is that the public would not be opposed if they had the technical understanding that scientists have. In 1970, Sir Peter Medawar commented on public fears of genetic manipulation of microorganisms, saying, “I find it difficult to excuse the lack of confidence which otherwise quite sensible people have in the scientific profession, for their fearfulness, laymen have only themselves to blame, and their nightmares are a judgment on them for their deep-seated scientific illiteracy.”

Contemporary elite scientists tend to also think that opposition from the public comes from the public’s lack of knowledge about science. In other words, scientists believe in what science communication scholars call the “knowledge deficit model,” the belief that “Ignorance is at the root of all social conflict over science. Once citizens are brought up to speed on the science, they will more likely judge scientific issues as scientists do, and the controversy will go away.”



This model is “the great myth in science communication.” People who have studied the matter have concluded that an individual’s knowledge of science and technology has little to nothing to do with whether he or she supports science or technology. It turns out that the conflict is not over knowledge or facts but over values. According to one meta-analysis of the literature, “Scientists often believe public debates should turn on logic and cross-benefit analyses, whereas the public wants consideration of factors such as fairness, ethics, and accountability.”

Thus, the reason people with higher levels of education are more supportive of the innovations being made by scientists is not that they understand the science better but that higher education tends to teach the same set of values that are shared by the scientific and medical community. So while

## Higher education tends to teach the same set of values that are shared by the scientific and medical community.

educating the public about stem cells might be inherently good, such education is not going to make people more supportive of controversial science and technology.

The second characteristic that shows up in these surveys is religion, which is actually a much bigger predictor of attitudes than education is. The myth is that religious people, particularly Protestants, are “opposed to scientific knowledge.” People reach back to the story – another myth, actually – of Galileo being put in jail by the Pope. The assumption is that religions have one method for making claims about the natural world – transcendent revelation through mechanisms such as the supernaturally inspired Bible – while scientists have a different method: the use of observation and rea-

son. Therefore, this assumption continues, religious people will be less supportive of all science because they believe in revelation and not observation. But this also is a myth.

Studies show that the religious public, by and large, is equally supportive of science as a way of describing the natural world. So, Catholics (those in the United States at least), Protestants, Jews, and other religious groups have no modern history of conflict with science over facts about the world.

Conservative Protestants do have a history of conflict with science over human origins, Darwin, and the like. But studies show that if you gather the most conservative Protestants you can measure in a survey (i.e., the approximately 10 percent of the public who are members of conservative Protestant denominations, are biblical literalists, and attend church every week) and compare them to nonreligious people,

you find no difference in the likelihood that they are scientists, in the number of scientific facts they know, in whether they know how the scientific method works, in the number of science classes taken, and so on.

They disagree with some facts – like human origins and the age of the earth – but they also know what scientists have to say about these things. They just disagree. They want to believe a few fact claims from the religious tradition instead of the scientific one.

But in general, when you interview the public, which is what I do for a living, what you find is that religious people, including conservative Protestants, love science. They love discovering the world. But they disagree about the values that are implicit in certain scientific claims or innovations.

I suspect many of you have seen the 1960 movie *Inherit the Wind*; it is a fictionalized account of the Scopes Monkey Trial. The defender of the fundamentalist position at the trial was the two-time Democratic Party nominee William Jennings Bryan. In the movie, he is portrayed as opposed to teaching Darwin because the Bible has a different account of human origins. But in reality, he was also opposed to Darwin because he believed that the values and morals Darwin had implicitly taught had damaged the morals of the youth of Germany and caused World War I.

Now, whether Bryan’s view makes any sense or is true is beside the point. Bryan was representative of the community at the time in thinking that concerns with Darwinism had to do with morals, not just facts. That belief is shared by anti-evolution people to this day. If you look at the intelligent design people, they are primarily motivated by moral concerns.

I recently published a paper looking at conservative Protestants and global warming research. Once you control for the fact that conservative Protestants tend to be disproportionately embedded in political conservatism – essentially, they watch a lot of Fox News – you find that conservative Protestants are as likely as anybody else to believe scientific claims about climate change. Opposition to scientific claims does not come from their religion, but from their political conservatism.

What they do not want is for scientists to be involved in the political debates about what to do about climate change. Why would that be? They think scientists do not share their values. What leads religious people to oppose the scientific community on some issues is not knowledge – or a lack of knowledge – about facts, but differences in values.

Something you will soon be hearing a lot about is gene editing using a technology called CRISPR. Let’s say you could success-

### **What leads religious people to oppose the scientific community on some issues is not knowledge – or a lack of knowledge – about facts, but differences in values.**

fully use somatic cell human gene therapy to cure an individual of sickle cell anemia. A defective gene would be replaced or a functional gene inserted into parts of the human body that cause the disease. That individual person would be healed.

All Americans would say that was a good thing. The studies I have conducted suggest that even the most ardent fundamentalist Protestants would agree, although they would describe their agreement in a way most people would not; that is, they would say, “It’s great that God gave us the brains to invent medicine to solve these problems.”

Now, many scientists would say, “That change in that person is going to die with them. What we really need to do is change the reproductive cells so they can’t pass that trait onto others. Ideally, we could remove the trait from the entire human genome.” Supposedly this sort of thing could be done with CRISPR, which is what everyone is talking about.

But educating the public about how CRISPR works is not going to change people’s views about what it can do. And here is where you get the values divide. Many religious people would say something like, “Human beings lack the wisdom to design themselves.” And the people who advocate changing the genes in an embryo would say, “We design ourselves all the time.” The religious people would then say, “I would have gotten off this train long ago,” and the advocates of the new technology would respond by arguing, “You are already on this train whether you like it or not.” The point is that the public derives its opinion about science and technology from values and that these

values are largely derived from their education and their religious beliefs.

I love scientific innovation. I look forward to the latest medical advances. In my opinion, though, the disconnect between those doing cutting-edge science and the public arises from the scientific community’s discomfort talking about the values their work advances. Instead, scientists are more comfortable – and, given their training, this makes sense – talking about facts. But I think science and the public would have greater understanding if the debate shifted to values. ■

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# Making Justice Accessible

On November 11, 2015, Diane P. Wood (Chief Judge of the United States Court of Appeals for the Seventh Circuit), Goodwin Liu (Associate Justice of the California Supreme Court), and David S. Tatel (Judge on the United States Court of Appeals for the District of Columbia Circuit) discussed issues of access to the justice system. The program, which served as the 2027th Stated Meeting and the Inaugural Distinguished Morton L. Mandel Annual Public Lecture, was streamed to gathering of members in four cities around the country: New York, Washington, Chicago, and Berkeley. The program concluded the first day of a two-day Academy symposium on the state of legal services for low-income Americans, which brought together federal and state judges, lawyers, legal scholars, and legal aid providers concerned about the state of legal services for Americans. The following is an edited transcript of Chief Judge Wood's, Justice Liu's, and Judge Tatel's remarks.



## Diane P. Wood

*Diane P. Wood is the Chief Judge of the United States Court of Appeals for the Seventh Circuit and a Senior Lecturer at the University of Chicago Law School. She was elected a Fellow of the American Academy in 2004 and serves as Chair of the Academy's Council and Vice Chair of the Academy's Board of Directors.*

It is our privilege to continue the conversation that some of us have been having during the day in our conference on the state of legal services for low-income Americans. The exact figure can be disputed, but on the civil side the unmet need for legal services might be as high as 80 percent. Even

**On the civil side the unmet need for legal services might be as high as 80 percent. This represents a huge number of people who would benefit from legal services but lack the financial ability to acquire them.**

if the figure is “only” 60 percent, that still represents a huge number of people who would benefit from legal services but lack the financial ability to acquire them. It is a percentage that is very damaging to our social fabric.

On the criminal side, the story is not much better. That might surprise you a little more. We have all seen plenty of TV programs that show police officers reading people their Miranda rights and telling them they have a right to a lawyer at public expense should they be unable to afford one. And, indeed, with exceptions for undocumented aliens (who face not prison but deportation) and people who have been charged with traffic offenses or misdemeanors that are regarded as too trivial, people do get a lawyer.

But what kind of a lawyer? One with an unmanageable caseload who may spend only five minutes with the client before walking into the courtroom and entering a plea?

We have two outstanding people to talk about this issue: first, Justice Goodwin Liu

of the California Supreme Court, recognizing that the state supreme courts play a critical role in the question of accessibility of justice; and second, Judge David Tatel of the United States Court of Appeals for the District of Columbia Circuit.



## Goodwin Liu

*Goodwin Liu is an Associate Justice of the California Supreme Court.*

**M**aking justice accessible is important because of a simple truth. We can have all the laws and guarantees we want written on paper, but none of them really mean anything unless they are put into practice. And that gap between what is on paper and what is in practice happens to be a big one in our country.

But it need not be that way. Other nations and other systems of legal-service delivery do not have the big gaps we do. So we really need to rethink this issue, lest the rule of law simply be something we observe in theory and not in practice.

In the interest of providing a descriptive map of the domains into which discussions of this issue typically fall, I offer three categories.

The first category I call the substantive law of access to justice. We have a lot of law to structure the way litigation proceeds. And the way it is structured affects greatly who can actually get their rights vindicated in court.

**The basic idea is that we have to achieve balance between ensuring legitimate access to the legal system and deterring frivolous and wasteful litigation.**

A prominent type of litigation is the class action lawsuit, which has become a hot point of controversy in the law and in the business world. The federal and state laws that modulate whether class actions can proceed have a huge effect on who can get their rights vindicated, especially in the consumer and employment fields.

Another example is fee-shifting statutes. The American rule is typically that each side bears its own fees. But sometimes, when legislatures want to incentivize the bringing of particular kinds of claims, they allow fees to be shifted, which means the winning party (the notion of who is a winning party is itself a concept in the law that needs to be elaborated) can collect its attorney's fees from the other side.

**American society is law-dense. All of these laws are well-intentioned. But as a whole, they create a system in which the accessibility of law depends increasingly on one's ability to navigate this morass.**

Another big area is arbitration, which originated as a mechanism for parties of equal bargaining power, typically merchants, to resolve disputes at low cost and great speed, achieving all the efficiencies that entails. Today arbitration is much more widely used in situations that perhaps were not originally foreseen a century ago.

With each of these strategies, the basic idea is that we have to achieve balance between ensuring legitimate access to the legal system and deterring frivolous and wasteful litigation. Of course, different people can have different senses of where that balance lies.

American society is law-dense. We codify into the law lots and lots of things. All of these laws are well-intentioned. But as a whole, they create a system in which the accessibility of law depends increasingly on one's ability to navigate this morass.

One example is the Individuals with Disabilities Education Act (IDEA). I don't think anybody would dispute that it is a well-intentioned law. But studies of the IDEA show that it can create a situation of haves and have-nots. Those who are aware of the rights guaranteed to kids under the law and can afford to hire a lawyer to use the procedural mechanisms detailed in the statute are going to have better results than those who are unaware or who cannot find a lawyer to help navigate the same morass. The law itself poses a "density" problem that creates inequalities of access.

The second category consists of more conventional reforms or initiatives within the legal profession or within law schools; that is,

using the existing tools of the legal profession but reforming, reorganizing, and fundamentally reworking them within the four corners of the profession, as we understand it today.

For example, the Legal Services Corporation provides legal services to indigent people. Its public financing and political support and the breadth of its mission have ebbed

## The idea is to promote a model of lawyering that ordinary people can afford. Can we provide legal services for roughly the cost of what people might pay a plumber, or an electrician, or a car mechanic?

and flowed. But we have a lot of levers we can use to adjust that particular mechanism.

Another example is the pro bono efforts of law firms and individuals. In some states, laws mandate or strongly encourage these kinds of efforts, with varying levels of success. But the overall idea is that members of the profession ought to be giving back, especially to communities that are in need. And so we use exhortation – and sometimes regulation – to utilize that particular lever.

I am involved in a California initiative that uses “incubator programs” to put young law graduates into training programs that help them start their own solo or small group practices that serve ordinary people. The idea is to promote a model of lawyering that ordinary people can afford in the way that ordinary people can afford a plumber. If your toilet is broken, you call a plumber to come fix it. Can we provide legal services for roughly the cost of what people might pay a plumber, or an electrician, or a car mechanic? Can we habituate people to use lawyers in the same way they use these other professions when they need to fix important problems in their lives?

The third category is economic regulation of the legal profession. The vantage point here is to step outside the four corners of the legal profession and ask more fundamental questions about why the legal profession is structured the way it is. That structure is a model that has survived at least a century. Our profession consists of qualified people who belong to one category only: lawyers. They do all the functions of lawyering, typically through brick-and-mortar enterprises that serve clients in a personal, one-on-one relationship.

Contrast this with medicine. One prominent feature of medicine in the contemporary period is the intense differentiation of function with respect to the delivery of healthcare services. The medical industry has proliferated categories of people: doctors, nurse practitioners, technicians of whatever stripe, nurses differentiated by many categories. This allows the industry to triage your needs to the lowest-cost provider who can take care of those needs, and then move you up to the next-higher-cost person only if necessary. Imagine if instead the healthcare profession had just one category: doctors.

Law is very different, and we need to ask some fundamental questions about whether the current structure of the profession produces unnecessary inefficiencies.

What is the scale of unmet legal need? Some of the work that has been done on this is startling. USC law professor Gillian Hadfield reports that legal aid lawyers contribute 1 percent of the total legal effort that is made in the country each year. One percent.

American lawyers average about 30 hours of pro bono work per year, which is another 2 percent of the total legal effort. What if we asked every lawyer in America to do 100 more hours of pro bono work a year? If on top of a typical 1,800-hour or 2,000-hour billing year, each lawyer added 100 more hours of pro bono work, what would we get? A drop in the bucket. All that additional work would be enough to secure less than 30 minutes per problem per household in America.

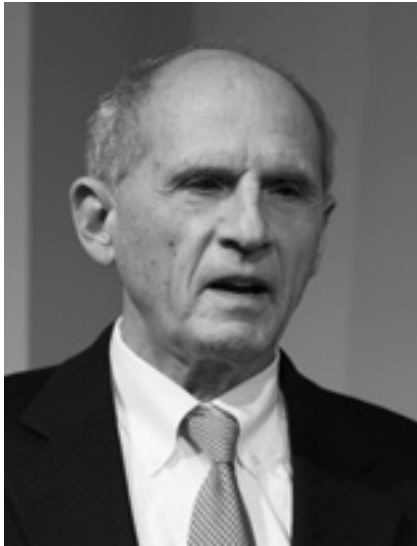
Average billing rates for lawyers in modest solo practices or small firms are rough-

ly \$200 an hour. If we used that as our rate (ignoring the big firms that can charge \$500, \$600, even \$1,000 per hour), we would need \$50 billion annually to give one hour of legal help to every American household every year. What do we actually spend on legal aid for such households? Less than 10 percent of that amount: \$3.7 billion.

We are not going to engineer our way to a solution that is truly at scale by working within the four corners of how we do law today. We need to figure out how to lower the cost of doing law. The ideas for how to do this are wide-ranging, but I think technology will have to be a part of the solution.

To make a dent in the vast problem before us, we need to put everything on the table for examination, including the role of technology, the role of different organizational forms, and the role other service providers (in categories other than lawyers) might play in the legal profession.





## David S. Tatel

*David S. Tatel is a Judge on the United States Court of Appeals for the District of Columbia Circuit. He was elected a Fellow of the American Academy in 2015.*

To be totally candid, when I received the invitation to this conference a couple of months ago, I put it aside. I've been attending conferences like this since the 1960s, when the legal services program was part of the Office of Economic Opportunity. All of the conferences had similar titles – “Improving Access to Justice,” “Serving the Unmet Legal Needs of the Poor,” etc. – and over the years, the number of poor people without access to the legal system has steadily increased. So attending another conference wasn't high on my agenda.

It hasn't always been this way. In the years immediately after the Legal Services Corporation was created, the situation was quite different. At that time, the Corporation had, in inflation-adjusted dollars, twice the budget that it has today, and it served half the number of poor people. Additionally, a network of university-based backup centers provided technical assistance and expertise

**In the late 1960s and early 1970s, we actually believed that poor people would have equal access to the legal system. We thought that goal was attainable.**

in substantive areas like housing, welfare, education, consumer rights, etc. These centers functioned as think tanks for legal services lawyers throughout the country.

In addition to that, the Reginald Heber Smith Fellowship program funded 250 of the smartest law school graduates to work in legal services programs. Two of my classmates at the University of Chicago Law School – both of whom were top students, and both of whom had elite federal court clerkships – went on to be “Reggies” in the Chicago legal services program. As an associate in a Chicago law firm, I worked with them on a pro bono case. I'll always remember the sign on their office door: “OEO Legal Services: Class Action and Test Case Division.” If a legal services office put up a sign like that today, Congress would defund it faster than it is trying to defund Planned Parenthood.

In the late 1960s and early 1970s, we actually believed that we would solve this problem – that poor people would have equal access to the legal system. We thought that goal was attainable. But today, some forty years later, 80 percent of poor people who need the help of a lawyer cannot get one. In Washington, D.C., that number is 90 percent. And in some fields, like housing, it's 98 percent.

Despite all this, I'm glad I came today. This conference has been extraordinary, and the ideas that have been discussed are important and intriguing. These ideas have focused on the nuts and bolts of providing legal services to the poor, as well as on the structural and substantive problems that need to be solved if we are to make meaningful progress.

But we must also be realistic. Even if all of the ideas we have discussed today bear fruit,

millions of poor people will still lack meaningful access to the legal system. For example, pro bono services are important, and the LSC taskforce on pro bono work produced a very helpful report. In fact, when law firm lawyers ask me what they can do, I hand them the report and say, “Here, this lays it out.” But everyone agrees that even greatly expanded pro bono cannot meet the vast legal needs of the poor. In my view, the only way to do that is by dramatically expanding federal, state, and local legal services programs. These are the programs that know how to provide high-quality, cost-effective legal services to large numbers of poor people. The problem, of course, is that Congress will never fully fund legal services. In fact, it will probably reduce its funding.

**Today, 80 percent of poor people who need the help of a lawyer cannot get one.**

There is, however, an institution that is capable of fully funding legal services for the poor, that is responsible for doing so, but that has failed to step up to the plate: the legal profession. Because not everyone agrees that the legal profession has such an obligation, let me explain.

Of course, the responsibility for meeting the legal needs of the poor is shared by many institutions: Congress, federal agencies, state legislatures, etc. But it falls to the legal profession to lead the way. Unlike people who run airlines, deliver packages, sell iPods, or operate virtually any commercial business, lawyers should not measure their success merely by how well they serve

those able to pay their bills. As officers of the court, lawyers have a broader responsibility to ensure that the legal system, society's mechanism for resolving disputes and protecting the rule of law, functions effectively – something it cannot do when a vast number of people lack access to it because they can't afford a lawyer.

The legal profession has this obligation for yet another reason: Lawyers enjoy a monopoly on the practice of law. No one can practice law who does not pass the examinations the profession administers and obey the ethical standards it establishes. With this privilege, along with the enormous profits it yields, comes a weighty responsibility. As gatekeeper to the legal system, the legal profession has an obligation to ensure that the gates are open not just to those who can pay its fees, but also to everyone entitled to the protection of the law.

Our efforts to satisfy the legal needs of the poor have fallen short in great part because

**There is an institution that is capable of fully funding legal services for the poor, that is responsible for doing so, but that has failed to step up to the plate: the legal profession.**

the Model Rules of Professional Conduct define a lawyer's responsibility to provide legal services to those unable to pay as an individual obligation. For example, the Model Rules call on every lawyer to perform fifty hours of pro bono service each year and to contribute a specified amount of money to legal aid. But the people who set that standard have abso-

**As gatekeeper to the legal system, the legal profession has an obligation to ensure that the gates are open not just to those who can pay its fees, but also to everyone entitled to the protection of the law.**

lutely no idea whether fifty hours from each lawyer will make a difference. As Justice Liu pointed out, it is unlikely to even come close. In my view, the profession should adopt a declaration of responsibility requiring that every lawyer's obligation, in addition to doing pro bono work, is to provide whatever financial support is necessary to ensure that legal services programs in their community have sufficient resources to meet the legal needs of every poor person. And the legal profession has the resources to do just that. Let me give you a couple of facts.

Fact number one: According to the census, the legal profession grossed \$250 billion in 2013. Just 0.15 percent of that – that is, 15 cents for every \$100 earned – would double the budget of the Legal Services Corporation and allow it to serve every client it now turns away. You might think that number is unrealistic, but in Washington, D.C., some twenty law firms have made financial commitments to local legal services programs that come close to that 0.15 percent. The country's hundred largest law firms alone could double LSC's budget with contributions of less than half a percent of gross revenues.

Fact number two: When law firms hire Supreme Court clerks, they give them very large bonuses. A year ago, the thirty-two clerks who joined law firms after their Supreme Court clerkships received almost \$12 million in bonuses. That \$12 million could have funded 150 legal services lawyers, doubling the number of such lawyers working in Washington, D.C.

Given these earnings, no one in this country should be denied access to the courts simply because he or she cannot afford a

lawyer. Our task now is to take a step back and determine what combination of private and public funding and pro bono services is necessary to accomplish that goal. Were I the president of the American Bar Association, I would convene the leaders of national, state, and local bars and urge the development of a national declaration of responsibility to serve the legal needs of all poor people. I would then sit down with the leaders of national, state, and local legal services programs and figure out how much money we can realistically get from Congress and how much from other sources. Then, through voluntary contributions, increased dues, or some other mechanism, the legal profession would provide the rest. ■

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

# Exploding Stars and the Accelerating Universe

On October 11, 2015, as part of the Academy's 2015 Induction weekend program, Alexei V. Filippenko (Professor of Astronomy and the Richard & Rhoda Goldman Distinguished Professor in the Physical Sciences at the University of California, Berkeley) discussed supernovae and the accelerating expansion of the universe. A condensed version of his remarks, not including the many supporting images and graphics he showed, appears below.



## Alexei V. Filippenko

*Alexei V. Filippenko is Professor of Astronomy and the Richard & Rhoda Goldman Distinguished Professor in the Physical Sciences at the University of California, Berkeley. He was elected a Fellow of the American Academy of Arts and Sciences in 2015.*

I am honored to have been inducted into the American Academy of Arts and Sciences and especially to have been chosen as today's featured speaker. I am also a bit frightened, however, because I have been given such an incredibly diverse audience. This is, after all, the American Academy of Arts and Sciences. So, I hope to have something for everyone in my talk this morning.

I will mostly be discussing supernovae: stars that explode. Only a small minority of stars do this at the end of their lives. They can become millions or even billions of

**If it can be so amazing to discover something on your own – even when lots of other people know about it – how thrilling must it be to truly discover or understand something that no human on Earth has ever seen or understood. That is what drives all of us who are scientists – the thrill of discovery.**

times brighter than the Sun. If the Sun were to do this – don't worry, it won't – sunblock of 50 wouldn't cut it! You would need sunblock, or supernova block, of a few billion to protect yourself.

So, why am I focusing on supernovae today? How did I get here? Well, in my youth I was very interested in nature. The first interest I can recall is magnets. I had this incredible obsession with magnets. You can hold them and feel that some sort of force is either attracting them together or repelling them. But you can't see it.

I longed to understand this force. When I played with magnets in the sandbox at school, I noticed that they picked up little bits of black stuff. I later found out that they are iron filings. The school I was attending at the time thought I was weird. I wasn't just memorizing a bunch of facts; I was doing all this other stuff. Also, I only ate peanut butter and jelly sandwiches back then. That disturbed them. They thought my behavior was kind of crazy, and they told my parents I should see a child psychologist! Now, please understand, I'm not against psychology; it's a good thing for many reasons, but being a kid in the first grade who is curious about nature isn't one of them!

So I started with this fascination with magnets. Then I played with electronics kits and microscopes and anything else my parents would give me – anything science oriented. After a while, I became really interested in chemistry. From age ten through seventeen, chemistry was my main passion. I built up an amazing home chemistry lab. Any dime I could earn I spent on equipment and chemicals. And I did a lot of quite sophisticated experiments, like making synthetic rubber and Bakelite and extracting mercury from cinnabar. It was lots of fun. But I was also sort of a basement bomber; I was interested in explosives.

At Dos Pueblos High School in Goleta, California, I was president of the science club, and occasionally I would have these explosion demos at lunchtime. Everyone loves flash powders. Anyone who is a chemist is interested, to some degree, in explosives. Seeing flash powders go off is just fun!

I remember one day I was holding one of my noontime demonstrations, and I didn't know that the ventilation system in my high school was interconnected among all the buildings. Apparently, smoke started pouring into the administration building. They were about to call the fire department

**Stars build up heavy elements in their cores. Yet if all stars remained dead, inert things at the ends of their lives, without releasing those elements, then those heavy elements would never become available for the production of other stars, planets, and life.**

when someone said, “Wait, let’s look at the weekly bulletin. Isn’t Alex Filippenko doing something with the science club today?” So, they came to the room, opened the door, and said, “Oh, it’s you. Okay.” Then they left. Nowadays it wouldn’t work that way, would it?

When I was fourteen and a freshman in high school, my parents gave me a small telescope because I had done other types of science but had not yet explored astronomy. Chemistry was still my passion, but I figured it would be good to explore astronomy as well.

I clearly remember going out that first night, setting up the telescope. I pointed it to a bright star, and the star looked even brighter. That was kind of thrilling: my first view through a telescope. And then I looked at a second bright star, and it looked brighter. That is what a telescope does; it makes things look brighter.

The novelty was beginning to wear off, though, so I thought, “Okay, tomorrow or the next day, I will go to the library and look up where the good stuff is.” (The Internet didn’t exist yet!) Then I would go and use my telescope for real. But before packing it in for the night, I thought I would look at one final bright star. I chose one and it looked a bit fuzzy, so I released the telescope to let the vibrations damp out, and I realized I was looking at Saturn.

Well, this knocked my socks off. That night, I discovered Saturn! It didn’t matter that millions of people had seen it before. No one had told me to look at that bright

star. I did it on my own, and I discovered Saturn.

That thrill of discovery has never left me. If it can be so amazing to discover something on your own – even when lots of other people know about it – how thrilling must it be to truly discover or understand something that no human on Earth has ever seen or understood. That must be really special. And that is what drives all of us who are scientists – the thrill of discovery.

So astronomy became a growing hobby when I was in high school. Chemistry was still my main passion, though, and I entered my freshman year at UC Santa Barbara in the College of Creative Studies as a chemistry major. Because I already knew quite a bit of chemistry, I was put in charge of helping design experiments for a junior physical chemistry laboratory. Most of the equipment that was purchased was of inferior quality. (That’s why they had an undergraduate trying to fix it.)

I soon got bored with it, though. After hours, when my supervisor had gone home . . . well, I had this incredible storehouse of material. I could play with explosives. I also did legitimate experiments. But I did things on my own. And one time I had a bad accident.

It was not the first. I had had an accident a number of years earlier, in my basement lab. But now I was a freshman in college; I should have known better. That taught me that I don’t have the self-discipline to stay away from this stuff. If I became a chemist, I would have all these dangerous chemicals at

my disposal, and one of these days I would blow myself up, kill myself, or lose my eyesight. And I didn’t want to do that.

So I thought, as a matter of self-preservation, if nothing else, I have to move out of this field. I took a class on astronomy from Stan Peale. He taught me that the structure and evolution of the universe as a whole, and its contents including the stars, depend on an understanding of microphysics – atoms and subatomic particles. I realized that by switching to astrophysics I could have it all. I could have the very small – the physical chemistry, the quantum chemistry in which I was most interested – and the very large. So at the end of my freshman year at Santa Barbara, I switched to physics with the intention of becoming an astrophysicist, and I have never looked back.

As a graduate student at Caltech, I did a lot of my work at the Palomar Observatory. I was studying galaxies at the time with Wallace (“Wal”) Sargent. Not normal galaxies, but a type of galaxy known as an active galaxy – in particular, Seyfert galaxies, which have a very bright central region.

What we think is happening in these galaxies is that they have a giant black hole, a region of space where matter is compressed so much that nothing – not even light – can escape. The black hole is sucking in material, and as that material is being devoured it glows. No radiation is escaping from within the black hole. Rather, it is escaping from the vicinity of the black hole.

I was trying to find evidence of these gigantic black holes in nearby normal galaxies by looking for faint activity in the galaxies. This is done by sending the light of the nuclei of the galaxies – the center of the galaxies – through a prism or related object and producing a spectrum, then measuring the brightness of the light as a function of color, or wavelength, and plotting the two.

A normal galaxy that is just forming hot, massive stars has bright emission lines be-



cause a lot of gas excited by ultraviolet radiation from these stars emits light. But a Seyfert galaxy has broadened lines, in some cases, because the gas is moving very, very rapidly in the vicinity of a massive black hole, whose gravity is pulling on it.

That is how you can distinguish an active galaxy from a more-or-less normal galaxy, which is what I did as part of my doctoral thesis (and also for some of my postdoctoral work at UC Berkeley). We used the “Big Eye,” the Palomar Observatory’s 200-inch, 5-meter Hale telescope. At the time, it was the biggest and best in the world.

Well, in February 1985 – I had recently become a postdoc at Berkeley, but I was still finishing projects related to my thesis – I had one hour left at the end of a long, five-night observing run. It was still early in this particular survey of galaxies, so we had hundreds of galaxies to observe. In this last hour, however, I had time to observe two galaxies. I said to Wal, “Well, let’s do this one: NGC 4618.” Some other astronomer had classified it as a peculiar galaxy, and there is no particular order in which you need to observe the galaxies, so why not choose this one?

In NGC 4618, we saw an extra star that looked like it didn’t belong. It didn’t seem to be in any of the charts we had. So we decided to take a spectrum of that star, as well as of the galaxy itself. That spectrum knocked my socks off, just like Saturn had done many years earlier.

In plotting the brightness versus wavelength, we saw broad emission lines, which I identified with neutral oxygen, singly ionized calcium, and neutral sodium, among other things. This was a spectrum like none other; no one had ever published such a spectrum before. We quickly realized we were probably looking at an exploding star but of a type never before recognized.

I could have chosen some other galaxy, one without that supernova. But I happened to choose this galaxy. I was handed an op-

portunity, and I ran with it. It is good to be lucky, but you also have to be prepared to be lucky and to take advantage of the opportunities that come your way.

What we observed that night turned out to be a new type of explosion. We now understand that it was a massive star that exploded in more or less the same way as many other massive stars are known to explode. They develop an iron core at the end of their lives. The core collapses, then rebounds and blows the outer layers outward. You end up getting what is called a neutron star. Then the ejected materials go flying out. But in this case, the star had lost its hydrogen shell, and maybe even its helium shell, leaving the denuded core of a massive star, prior to exploding. Stars can do this in various ways.

**The carbon in your cells, the oxygen you breathe, the calcium in your bones, the iron in your red blood cells – all of those heavy elements were cooked up in the cores of stars through nuclear reactions long ago and then ejected into the cosmos by these incredible explosions.**

Winds can blow out the outer atmospheres of very massive stars on their own, or the star can be in a gravitationally bound pair with another star, which steals the hydrogen and helium layers away from it.

What we found was a known type of explosion in unknown clothing. The clothing had basically been stripped away, leaving a naked exploding star.

This discovery got me all jazzed up about supernovae. I thought, “Wow, these things explode!” And this brought me back to my old chemistry days. I’m still a chemist at heart, in some ways!

Besides being thrilling to watch and study, these explosions are critical to our

existence. Stars build up heavy elements in their cores. Yet if all stars remained dead, inert things at the ends of their lives, without releasing those elements, then those heavy elements would never become available for the production of other stars, planets, and life.

But we need some way of getting these elements out. And exploding stars are the answer. That is how those elements get out. (The explosions themselves also produce additional heavy elements.) The carbon in your cells, the oxygen you breathe, the calcium in your bones, the iron in your red blood cells – all of those heavy elements were cooked up in the cores of stars through nuclear reactions long ago and then ejected into the cosmos by these incredible explosions.

We can tell that this is happening, that the ejected debris from supernovae is chemically enriched, because we can take spectra of these gases and see that they have a large quantity of heavy elements in them, elements that did not exist in any significant quantity prior to the star’s birth and explosion. And we can see these supernova remnants expanding for thousands of years. Gradually they merge with other clouds of gas, some enriched, some not, and you get gravitationally bound clouds like the Orion Nebula, which then start gravitationally collapsing. In the central regions of such a collapsing cloud, the cloud fragments into little pockets that themselves form stars.



The Orion Nebula is chemically enriched. About 2 percent of its mass comprises elements heavier than hydrogen and helium. All those other elements were produced by generation after generation of stars, because the Big Bang basically produced only hydrogen and helium.

Dusty disks form around some of the new stars. The disks are undoubtedly coalescing to form new planetary systems. Some of those planets will be rocky, Earth-like planets, because now the gases have been sufficiently enriched by previous generations of stars to contain enough of the heavy elements needed to form rocky, Earth-like planets.

On at least one such planet – Earth – life somehow formed. I will leave the mystery of life’s origin to the biologists to solve! By the way, everything in biology is more complex than in astrophysics, because even the simplest cell is far more complex than any inanimate object. My fellow astrophysicists and I have an easy time compared to biologists.

So, somehow life formed and evolved sentient creatures that have the intelligence to understand complex things; that have the curiosity, the inquisitiveness, to ask questions; that have the ability and the dexterity – the opposable thumbs – to build machines with which to answer those questions. “Atoms with consciousness,” Richard Feynman called us.

What I have been talking about is the origin of the elements – the elements in our DNA. This is why supernovae are important to you. Without them, you would not be here.

Now we want to understand this explosive process in more detail, and learn which elements are produced in each explosion. But a galaxy might produce a star like this only every thirty or forty years. If I were a really cruel advisor, I would have each of my students staring through the eyepiece of a telescope at one, and only one, galaxy, until that student found a supernova. Only then would we let that student graduate and

move on to greener pastures. Meanwhile, I would have decades’ worth of slave labor from said student. Fortunately for my students, some crimes are so egregious that even a tenured professor cannot get away with them!

## We found that different Type Ia supernovae actually do look spectroscopically different.

A more humane option would be to have the students look at thousands of galaxies. Statistically, if there is one supernova per galaxy per century, that’s the same thing as one supernova per one hundred galaxies per year. Each of those one hundred galaxies will produce a supernova sometime in the next century; we just don’t know when. But if we look at one thousand galaxies, we are likely to find ten supernovae. I could have my students view thousands of galaxies at night, but even that would still be considered cruel and unusual punishment.

Thanks to modern technology we have a better technique. We can attach digital cameras, like the CCD camera in your iPhone, to the eyepiece end of the telescope, take photographs of thousands of galaxies, and then simply look for arrows. Wherever you see an arrow, you see an exploding star. By rigorous mathematical induction, I conclude that this process must work every time!

Well, obviously it cannot be that simple. What we did at Lick Observatory was develop a robotic telescope that looks at nearly ten thousand galaxies each week or two, then repeats the process and automatically compares the new pictures with the old ones.

Once we have something that looks like it might be real, the undergraduate students eliminate the bad candidates by eye. Our software is getting better and better, though. Someday it will be sufficiently good to replace all of us. Until then our students

get to look at those candidates and help discover supernovae. They get their hands dirty with research early. Most of them do not go on to become astrophysicists. Instead, they pursue areas that are more immediately useful to society, such as computer science, ap-

plied physics, and engineering. But they get research experience on my team.

For a decade, we found more relatively nearby supernovae than all other teams in the world combined. Recently, however, the numbers have been dribbling down because other teams have been finding lots of supernovae; we have altered our strategy to find not many, but few, and early when they are very young. We do this by looking at the same galaxies the same night or every other night, rather than every week or two.

I am very proud of my team. We found the first supernova of the new millennium (regardless of your definition of the new millennium): both “Supernova 2000A” and “Supernova 2001A.” Our very first discovery was “Supernova 1997bs.” The name refers to the order of discovery (they go A, B, C, through Z, then aa, ab, ac, through az, and so on). But, interestingly, although we thought it was a legitimate supernova, our recent studies suggest it may have been an imposter. Sometimes stars burp in such a way that they do not completely destroy themselves. They are not really supernovae, even though they look like one.

Using spectra, astronomers have grouped supernovae into two main types and several subtypes. The one I am most interested in is the so-called Type Ia. Supernovae of this subtype come from stars called white dwarfs. Our own Sun will become a white dwarf in about seven billion years. A white

dwarf consists of a type of matter known as degenerate matter – not because it is morally reprehensible; this is just the term quantum physicists give to a very compactified type of matter.

## We now understand that the redshift is caused by the expansion of space itself.

But our Sun won't explode as a Type Ia supernova. For a white dwarf to explode, it needs to gather mass from a companion star in a binary system. There are various ways it can do this. One mechanism is for the more-or-less normal star, near the end of its life, to give mass to the white dwarf, which eventually explodes. Subrahmanyan Chandrasekhar is the one who basically figured out that white dwarf stars have a maximum possible mass.

Because they all explode at the same mass, the explosions were thought to be virtually identical, and observational studies of Type Ia supernovae showed that they are indeed all quite similar, to a first approximation. This is like one light bulb looking roughly like every other light bulb.

This observation increased the prospects for using Type Ia supernovae as yardsticks. If you can measure the observed brightness of a distant object and compare that with how powerful it really is, then you can figure out the object's distance. However, it turns out that observationally, they are *not* all exactly the same, and my group in the early 1990s made some rather major contributions to this field by getting high-quality spectra of Type Ia supernovae with the 3-meter Shane telescope at Lick Observatory.

We found that different Type Ia supernovae actually do look spectroscopically different. They weren't all the same, just as not all light bulbs are the same: some are bicycle light bulbs, some are the headlights of big

trucks, and so on. Spectroscopically different Type Ia supernovae also have differences in peak luminosity or power. But if they aren't all the same, that means maybe we can't use them to determine accurate distances, right?

Mark Phillips at the Cerro Tololo Inter-American Observatory (CTIO) in Chile, and later Mario Hamuy (also at CTIO), figured out a way to calibrate the power of these supernovae, as did Adam Riess in his PhD thesis work with Bob Kirshner at Harvard. They found that the more luminous Type Ia supernovae take longer to brighten and longer to fade than the less luminous ones. If you figure out this relationship by observing a bunch of Type Ia supernovae in nearby galaxies whose distances have already been determined, and then you measure the light curve of a distant Type Ia supernova, you then know from where in the distribution of luminosities this particular supernova is. Is it average? Is it overluminous? Underluminous?

By greatly decreasing the dispersion in the relationship and also figuring out more accurately what the supernova's luminosity is, we can precisely calibrate nearby Type Ia supernovae. And that is what made them incredibly useful as cosmological distance indicators.

In 1929, Edwin Hubble showed that nearby galaxies, though moving away from us, are moving more slowly than distant galaxies. All galaxies are moving away from us, but the more distant ones are moving faster than the nearby ones. You can see this from a spectrum. A nearby galaxy might have a spectrum that indicates a very low speed or even close to being at rest. A distant galaxy has the same, or more or less the same, pat-

tern of lines, but the spectrum is shifted toward longer wavelengths.

We now understand that the redshift is caused by the expansion of space itself. Basically, objects such as observatories and light bulbs and human beings are not expanding because we are held together by electromagnetic forces. The Earth and our Milky Way Galaxy are held together by gravity. But things that aren't tied down by stronger forces expand. In particular, a light wave not tied down by anything in the universe expands as the universe expands, and this is the fundamental cause of what is called the cosmological redshift: it is *not* a motion through preexisting space but rather an expansion of space itself.

Nevertheless, from our perspective in the Milky Way, all the other galaxies are moving away from us. The more distant ones, at a given time, are moving away faster than the nearby ones. And we are at the center. Why would we be at the center? Do the other galaxies not like us? Is it something we said? Does the Milky Way smell? Are all these other galaxies lactose intolerant?

Actually, we don't think we are in any central position. We think we live in a uniformly expanding universe. Imagine an expanding loaf of raisin bread. Yeast is spread uniformly through the dough. After sitting around for an hour, the loaf doubles in size. (Imagine it is an infinite loaf or that it wraps around itself.) From the perspective of any single raisin, the other raisins move away. That one raisin thinks it is at the center, but so do all the other raisins. Of course, none of them is at the unique center. There is no unique center, at least not in dimensions that we can physically probe. There may be a unique center in a mathematically describable dimension, but we can't see it or physically access it.

So, the universe is expanding. If we extrapolate that expansion back in time, we get the Big Bang: the moment of origin, when the universe was hot and compressed.

With big telescopes such as the Hubble Space Telescope, we have been able to measure the current rate of expansion.

Based on principles going all the way back to Isaac Newton, we expect the expansion of the universe to be changing with time. Newton supposedly saw an apple fall from a tree while he was at his parent's countryside home escaping the plague. He wondered whether whatever caused the apple to fall was related to the orbit of the Moon around Earth. With his law of universal gravitation he tied together terrestrial phenomena with celestial phenomena.

All galaxies have visible matter in them, the gravitational attraction of which should cause them to slow down in their recession away from one another. However, they have even more of what is called dark matter. Dark matter was first proposed by Fritz Zwicky, a hero of mine at Caltech. He was way ahead of his time on a number of issues, and one of his ideas was dark matter. He basically said that clusters of galaxies appear to be gravitationally bound, but the galaxies within them are moving so quickly that they would fly apart from one another unless some extra gravity were holding them in. He presented this idea in the 1930s and was uniformly ignored. So was Vera Rubin in the 1970s, when she reintroduced the idea using spiral-galaxy rotation curves.

Perhaps one reason why Zwicky's ideas were often rejected was that he was not a very friendly guy. He was frequently arrogant and abrasive. He didn't think highly of the intellectual capacity of his Caltech colleagues, and they in turn did not look kindly upon this guy who thought they were all a bit dim. (He is on record as having referred to his colleagues as "spherical bastards." Because, you know, they're bastards any way you look at them.)

What is dark matter? We don't really know. We think probably it is weakly interactive massive particles – little particles left

over from the Big Bang that interact only through gravity and the weak nuclear force. No one has compellingly detected one yet. Like neutrinos (another weakly interacting particle), they are very difficult to detect. In the case of neutrinos, if I could send a beam of them through a block of lead ten trillion kilometers thick (one light-year thick), about half of them would make it through without having bounced off of anything.

All this visible matter and dark matter should be slowing down the expansion of

many times, I could figure out how much it has been slowing down, and thus I could use the laws of physics to predict the future – whether it will someday come back down or continue going away forever.

In a similar way, if we measure the expansion history of the universe, we can predict what it will do in the future. We know the current rate of expansion. We next have to place ourselves back in time, to measure what the rate of expansion used to be, and then we can compare the two.

### **So, the universe is expanding. If we extrapolate that expansion back in time, we get the Big Bang: the moment of origin, when the universe was hot and compressed.**

the universe – just as the mutual gravitational attraction between Earth and the apple slows down the apple. If there is enough matter in the universe – if the density is high enough – the universe should expand and then collapse. What began with a Big Bang should end with a Big Crunch (or you could call it a “gnaB giB” – the opposite of a Big Bang!).

That is one possible fate. The other possible fate is that the density of the universe isn't sufficiently high to cause a recollapse. As everything moved apart, the expansion would continue to slow down, because you can never cut off the effects of gravity – but it would never reverse its motion. The universe would be eternally expanding.

We would like to know what kind of a universe we live in regardless of any practical application. How can we do that? Imagine an apple thrown straight up, with a speed either below or above Earth's escape speed. As it moves away from Earth it will gradually slow down because of the effects of gravity. If I were to measure the speed of the apple at

How do we effectively go back in time? We look at distant objects. We see the Sun as it was a little over eight minutes ago, because that is how long the light took to travel to us. The stars we can see with the naked eye appear to us as they were some tens or hundreds of years ago. Galaxies that are a billion, four billion, nine billion light-years away, we see as they were one, four, nine billion years ago.

We can also measure how much the universe has stretched during the time the light was in transit. That is the redshift. You get the redshift as a function of distance, or equivalently as a function of look-back time. That gives you the expansion history of the universe.

Back to the apple: if I throw an apple in the air, it comes back down thanks to gravity. But if there were no gravity, the apple would not slow down at all; it would move away from me linearly, neither accelerating nor decelerating. If there is some gravity, then the apple slows down with time. Similarly, how much the universe slows, and

whether it turns around, depends on the average density of the universe divided by some critical value, and that ratio is called  $\Omega_m$  (“Omega matter”). For dense universes ( $\Omega_m > 1$ ), you have the Big Crunch. For empty universes ( $\Omega_m = 0$ ), you have no deceleration at all. For medium-density universes (say,  $\Omega_m = 0.3$ ), you have an intermediate amount of deceleration.

That is the theorist’s explanation. Since we want to translate this into actual measurements of the past, we look at the redshift. It turns out that one plus the redshift is simply the size of the universe – or the distance between galaxies – now divided by the distance they were apart at the time the light was emitted. So, for example, redshift one means you are looking at light that was emitted in the universe at a time when the universe was half its present size.

Different expansion histories correspond to different look-back times and thus to different distances. For a given galaxy’s redshift, depending on what the universe used to be doing, that galaxy will be at different distances from us. The smallest distance, smallest look-back time, for the densest universe; bigger distances, bigger look-back times, for less-dense universes.

If you measure galaxies at many different redshifts and you figure out their distances, you can plot what the universe has done. All of the redshift versus distance curves have the same slope now, because all galaxies are moving apart from one another at whatever speed they have right now. But at bigger redshifts, the curves diverge from one another.

Fortunately, we can measure redshifts easily from spectra. We can measure distances from Type Ia supernovae. In a nearby galaxy, you just find a star whose properties you know. Let’s say we found a star in such a galaxy. We will call it Jonathan. Jonathan is like Betelgeuse, the left shoulder of Orion – a big, powerful, mighty star. We know Betelgeuse’s distance and its apparent bright-

ness, and that allows us to determine its true power. We know Jonathan is the same kind of star, so compare the two. That gives Jonathan’s distance, and hence the distance of the galaxy. Choose another star, Donald, and get the same distance; that gives you some confidence in your technique, especially if even more stars yield the same result.

What you are doing is similar to estimating the distance of a car by looking at its headlights. If you know how bright the headlights are when the car is only 2 meters away, then you can make distance estimates based on how bright the headlights appear to be. Most of you can make this calculation intuitively, almost instinctively. You are actually using the inverse-square law of light, and if you are not very good at doing it quickly, you should not be driving at night.

But for galaxies that are billions of light-years away, you might think there are no individually visible stars, so how can you use this technique? Well, it’s true: no *normal*

## **What is dark matter? We don’t really know. We think probably it is weakly interactive massive particles – little particles left over from the Big Bang that interact only through gravity and the weak nuclear force.**

stars are visible because they’re faint and blurred together. But supernovae can be seen, and distinguished from their neighbors, even billions of light-years away.

So, we try to find faint supernovae in distant galaxies. Those allow us to determine the distance of the galaxy using the inverse-square law. Moreover, the spectrum tells us how much redshift there is: how much the universe has expanded while the supernova light was on its way.

My main job on the High-Redshift Supernova Search Team led by Brian Schmidt and on the Supernova Cosmology Project led by

Saul Perlmutter was to get spectra of supernova candidates. Two teams meant there was competition; both wanted to be first, both wanted to be the best. That accelerated progress in the field and improved the quality of the work. Plus, it lent credibility when we came up with a crazy result.

Using CTIO in Chile, both teams would take wide-angle pictures of the sky containing thousands of galaxies. Then they would repeat the procedure three weeks later and subtract the earlier picture from the later picture. You get a bunch of noise, but that’s okay; any measurement process necessarily has some noise associated with it.

Sometimes we got something that looked like it might be real. To make sure it’s a Type Ia supernova, and to measure the redshift, I used the world’s most powerful optical telescopes, the two 10-meter telescopes at Keck Observatory in Hawaii. With those gigantic mirrors, we collected light from these faint supernova candidates, spread the light out

into a spectrum, and examined the data. For example, the spectrum of SN 1999ff shows that it is a Type Ia supernova at a redshift of 0.455, or about five billion light-years away.

The Type Ia supernovae we found were really, really faint. Looking at images of some examples, you might say, “Well, sure. They are in these faint, pathetic-looking galaxies that are obviously very distant.” That’s true, but these supernovae are fainter than they had any right to be. Given their redshifts, they could not have been that faint in a decelerating universe, or even in a universe expanding at a constant speed. They didn’t



fit any of the theoretically expected curves. They were too far away to be consistent with a dense universe or a medium-density universe or even an empty universe.

So, instead of deceleration caused by attractive matter, it looks like the opposite is going on: acceleration caused by *negative matter*. What? Wrong sign! You can see why we were afraid of announcing this result!

My postdoc at Berkeley at the time, Adam Riess, was charged with analyzing the data. His analysis showed, " $\Omega_m = -0.36$ ." The negative sign indicates negative deceleration, which means *acceleration*. This was the eureka moment, but when Adam showed me the results I didn't really believe him at first. But then other people on the team did the measurements and analysis, and Adam redid them, and we couldn't find anything wrong.

What this finding implies is perhaps not negative matter – which seems pretty crazy – but an idea that Albert Einstein came up with in 1917. Einstein said, "You know, the universe appears to be static." He and others thought the universe was neither expanding nor collapsing; there was no evidence for either possibility back then. So he conjured up something that he called the cosmological constant. He came up with the idea of a repulsive effect that negates gravity and, in his view, had exactly the same magnitude as gravity. The net force is 0, meaning no acceleration.

But he never liked this solution; it relied on something of unknown physical origin for which there was no laboratory evidence. And it made his equations less pretty. All in all, it looked arbitrary, ad hoc. So twelve years later, when Hubble revealed the expansion of the universe, Einstein renounced his own idea as having been the biggest blunder of his career.

Well, what have we done, the better part of a century later? We have reincarnated Einstein's idea. Not to make a static universe, but rather one that over the biggest distances accelerates with time. One that is

consistent with these data. Not with some form of matter that has negative gravitation but with a new type of energy – let's say Einstein's cosmological constant – that causes a repulsion.

## If we measure the expansion history of the universe, we can predict what it will do in the future.

The news headlines about our work said, "Astronomers see a cosmic antigravity force at work." We used the term "antigravity" hesitantly, however, because people then want to know if they can attach this stuff – whatever it is – to their cars and levitate over the traffic jams in Boston or LA. And the answer is no. This stuff is either a property of space itself, something that can't be harnessed; or it is a new type of energy, but one that will essentially never be harnessed because there is so little of it.

But is it really the cosmological constant? Is it Einstein's idea? Well, it might be. That would be a property of space itself, the vacuum: particles and antiparticles coming into existence and then disappearing a short time later. That, in and of itself, is not strange. In fact, it is the basis for a field of physics called quantum electrodynamics, for which Richard Feynman is famous.

However, physicists had always assumed that the net energy density of the vacuum is zero. If it is *not* zero, then it would actually have the desired effect of accelerating the universe. But a lot of physicists still think the net effect of this is zero and that the accelerating expansion is caused by something else. The general term for that something else is "dark energy."

One form of dark energy, in a sense, is the cosmological constant, but it is a qualitatively different form than other dark-energy candidates. It is a vacuum energy, whereas most of the other candidates would be a new

type of Higgs field. Not the Higgs field that gives mass to particles, but another type.

There is some sort of a dark energy density of the universe that is repulsive. Its value is greater than zero. Early in the universe, it

was actually of negligible importance, so the universal expansion was slowing down. But about four or five billion years ago, its total cumulative effect became comparable to, or exceeded, the effect of visible and dark matter, and so the universe started accelerating, and this is what it is doing now.

To test whether the universe actually went through this period of early deceleration, we used the Hubble Space Telescope to find and study very distant supernovae. We showed that this period of deceleration really did occur, for roughly the first 9 billion years of the universe's existence.

You might justifiably ask, "If this acceleration result is based just on Type Ia supernovae, could it be wrong? What if we are misinterpreting the data in some way? What if supernovae evolve in some way we haven't taken into account?" In science we all recognize that we have to verify using independent techniques. And the more important the result, the more important it is to independently verify. Our results have now been confirmed in many different ways, including by studies of the afterglow of the Big Bang using the Wilkinson Microwave Anisotropy Probe.

Those studies found "freckles" in the early universe that correspond to temperature variations, which themselves correspond to density variations. The observed angular sizes of the typical variations, together with their known physical sizes and their distance, show that something must



## Instead of deceleration caused by attractive matter, it looks like the opposite is going on: acceleration caused by *negative matter*. What? Wrong sign!

be making the universe spatially flat. According to Einstein's general theory of relativity, there has to be an extra density of the universe to make it Euclidean in its global properties. This is consistent with the presence of dark energy as revealed by the Type Ia supernovae.

Moreover, if you take these tiny density variations and propagate them through time using computer simulations, you can look at the growth of what is called large-scale structure: the galaxies, the clusters of galaxies, and the giant voids between them. If you don't include dark energy, the results of computer simulations end up not looking quite like the observed universe. But if you *include* dark energy when simulating the

ics. Dark energy even provides clues to the much-desired unification of quantum physics and general relativity.

We are now trying to measure more precisely the expansion history of the universe in order to rule out some of the candidates for dark energy. Different types of dark energy will lead to slightly different past histories. So we are trying to set observational constraints on what the dark energy might be.

How will the universe end? If the dark energy continues to be repulsive, then the universe will expand faster and faster with time – a runaway universe. This means that if you want to look at a galaxy with your very own eyes through a telescope, you had better do it pretty soon, at most within the next few

Some say the world will end in fire,  
Some say in ice.

From what I've tasted of desire  
I hold with those who favor fire.  
But if it had to perish twice,  
I think I know enough of hate  
To say that for destruction ice  
Is also great  
And would suffice.

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

## The physical origin of repulsive dark energy is, in the opinion of many, probably the most important observationally motivated, unsolved problem in all of physics.

growth of large-scale structure, then you get a computer prediction that looks a lot like the observed universe.

The census of the universe is now the following: dark energy is 70 percent and dark matter is 25 percent, which means we don't understand 95 percent of the universe. So, for anyone who says physics and astrophysics are dead, you can ask them, "Well, what about the origin and nature of most of the universe?" The physical origin of repulsive dark energy is, in the opinion of many, probably the most important observationally motivated, unsolved problem in all of phys-

tens of billions of years. After that time, the galaxies will have been whisked away beyond any distance from which they can be seen.

On the other hand, we don't really know that this will happen; it's possible that the dark energy will someday reverse sign, becoming gravitationally attractive. In that case the universe could still, ultimately, recollapse, ending in fire rather than ice. Though these two cosmological possibilities had not yet been articulated, Robert Frost's famous 1920 poem, "Fire and Ice," seems entirely appropriate in retrospect:

# Induction Ceremony 2015: Presentations by New Members

**O**n October 10, 2015, the American Academy inducted its 235th class of members at a ceremony held in Cambridge, Massachusetts. The ceremony featured historical readings by Vicki Sant (The Summit Foundation) and Roger W. Sant (The AES Corporation), as well as a performance by the Boston Children's Chorus. It also included presentations by five new members: Phil S. Baran (The Scripps Research Institute), Patricia Smith Churchland (University of California, San Diego; Salk Institute for Biological Studies), Roland G. Fryer, Jr. (Harvard University), Sally Haslanger (Massachusetts Institute of Technology), and Darren Walker (Ford Foundation). Their remarks appear below.



## Phil S. Baran

*Phil S. Baran is the Darlene Shiley Professor of Chemistry at The Scripps Research Institute. He was elected a Fellow of the American Academy of Arts and Sciences in 2015.*

**I**t is a great honor to be addressing this distinguished crowd of brilliant minds on behalf of Class I, the Mathematical and Physical Sciences. Today I would like to talk about something you might consider odd – namely what I believe the scientific community can learn from one of Elon Musk's society-changing companies, SpaceX. But first, a little background. I am a chemist and have been one for over 20 years, but before I fell in love with mixing reagents and creating new forms of matter, I fell hard for astron-

**Countless life-saving medicines, agrochemicals, unprecedented materials, light-harvesting polymers, longer-lasting paints, and rust-free cars are possible because of advances in fundamental organic chemistry.**

omy. The wondrous feelings evoked when peering into the night sky, the promise of new, unthinkable phenomena waiting to be uncovered is powerful and moving even without a telescope. Ultimately, though, the reason I chose to become a chemist instead of an astronaut or astrophysicist was principally for pragmatic reasons. I did not have the coordination to make it through the rigors of astronaut training, and my limited mathematical ability would have made me a very enthusiastic, but fairly useless, astrophysicist. Instead, I found in organic chemistry, specifically chemical synthesis, not only the wondrous sense of discovery that I imagined Captains Kirk and Picard felt on the starship Enterprise, but a place where I felt my passion could be put to good use.

During my schooling I was rewarded with exceptional mentors and a myriad of exciting opportunities to explore, discover, and create. I never needed to worry about funding a lab, or where my equipment was going to come from, and I certainly did not need to worry about doing something broadly useful that would lead to a direct application or product in real life. No, I was shielded from all of that, and like the archetypal scien-

tists in the days of yore, my job as a graduate student and postdoctoral associate was simply to focus on learning and discovering fundamental chemistry without regard to an eventual downstream impact. After all, what I was doing was government-funded basic research.

When I started my organic chemistry-focused independent career in 2003 at The Scripps Research Institute, however, things were clearly beginning to change. As I submitted some of my first grants it became apparent that the tides were shifting, with government agencies like the NIH being much less receptive to funding basic research in the arena of chemical synthesis. While the NSF certainly still funded such studies, the level of competition and the size of the pool of money awarded were so small that I could not rely on NSF funding to sustain a lab of more than one or two people.

This shift seemed bizarre considering the track record that chemical synthesis has had in the betterment of humankind. Countless life-saving medicines, agrochemicals, unprecedented materials, light-harvesting polymers, longer-lasting paints, rust-free cars – all of these things are possi-

ble because of advances in fundamental organic chemistry. It is a field that is both an art and a science, full of charm and wonder, with only the most rudimentary reactions being amenable to automation. Arguably, it is a quiet industry that makes modern-day life possible, yet it seems to be constantly questioned in terms of its inherent value. Among the myriad of comments I have heard about synthesis, the most consistent criticism is that it should be more interdisciplinary, diluted as to no longer be recognizable as a basic science but rather as a tool to help biology or physics. But that analysis is deeply flawed. It erroneously assumes we can do whatever we want in chemical terms, convert any molecule into any other material efficiently, on scale, and in environmentally benign ways. For some strange reason, despite the overwhelming case for societal support of chemical synthesis, the writing was on the wall that funding this area of inquiry would only continue to diminish.

That brings me to Elon Musk and SpaceX. Its self-described mission is simply to occupy Mars, turning the human race into a species capable of interplanetary colonization. What an awesome mission. Elon Musk felt the need to start this company in 2002 when he noticed that NASA had no realistic plans to achieve this objective, because it too was the subject of significant budgetary cuts and a focus on short-term, winnable goals. In fact, humans' ability to go to space had not evolved much beyond our brief explorations of the Moon, and advances in rocket technology stagnated several decades ago. What has happened?

I believe society simply has lost its appetite and passion for investments in space travel even though such endeavors have led to a multitude of useful inventions and taught us countless lessons. With so many other hot political issues these days, it would be challenging, to say the least, to ask taxpayers to spend billions on the seem-

ingly fundamental goal of setting up what some might consider to be a campground on Mars. So Mr. Musk's brilliant idea, something we can all learn from, was to fund this very fundamental mission by having the private sector pay for the underlying science and engineering needed to get there. By inventing reusable rockets and decreasing the cost of launching satellites, SpaceX could one day dominate the market and even invent new markets. The profits from that endeavor, likely coupled with NASA contracts when the risk seems much lower, will one day allow humans to set foot on Mars.

A tiny version of this strategy has been our laboratory's inspiration over the past decade. One of our scientific missions has been to invent practical routes, through a process known as total synthesis, to gener-

## **Society's message to scientists is clear: simple curiosity is insufficient justification for our research.**

ate some of nature's most complex and medicinally important natural products, such as the famous anti-cancer terpene, Taxol, in a laboratory setting. Once a billion dollar drug, this natural product is now made through plant cell fermentation in metric ton quantities every year. Meanwhile, hundreds of chemists labored in a style reminiscent of the Manhattan Project to create a few milligrams of synthetic material in the 1990s. That accounts for a roughly  $10^8$  difference in throughput, and in my view, an awesome opportunity for innovation. Like going to Mars, such a mission can be hard to fund when a long-term vision is needed, so we turned to the private sector. Teaming up with a large pharmaceutical company, we developed some of the underlying techniques and mission plan we would later need for Taxol by targeting other bioactive terpene natural products that were of inter-

est to them. The graduate students involved in the project were energized to be working on fundamental science with immediate commercialization potential, and the company was thrilled to have a solution to its problem. We are not finished with Taxol; not even close. But by partnering with the private sector, we are light-years closer to our goal than had we relied solely on public funding.

Ladies and gentleman, society's message to scientists is clear: simple curiosity is insufficient justification for our research. Scientists are great at thumping our chests and getting on our soap boxes about the importance of fundamental research. And, we are right. The problem is that nobody is listening. The average taxpayer has no idea what we do and the long-term benefits of basic

science. Arguably, the public is more interested in the air pressure of a football than the atmospheric pressure on Mars. Moving forward, in addition to making the most of precious public funding and occasional philanthropy, perhaps we should follow Mr. Musk's lead and turn to the private sector to help fund our own missions to Mars.

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## Patricia Smith Churchland

*Patricia Smith Churchland is Professor of Philosophy Emerita at the University of California, San Diego and adjunct Professor at the Salk Institute for Biological Studies. She was elected a Fellow of the American Academy of Arts and Sciences in 2015.*

I am truly honored to be here, on this colorful fall day in Boston. I am particularly honored to be speaking as a biologist on behalf of Class II, the Biological Sciences. My credentials, I must confess, are a bit unorthodox; some might say they are “turncoat” credentials, since my graduate training and my paying job were actually in philosophy – philosophy of mind, more exactly. But my passion for understanding the mind was channeled in a scientific direction as it became ever more apparent that if you want to understand the mind you have to understand the brain. Observing behavior and making concepts clear, though certainly helpful, is insufficient. Among the major inspirations was the split-brain research, showing that one hemisphere could be aware of things of which the other hemisphere had no clue. That consciousness

**As a science, neurobiology can help us understand why we tend to have a moral conscience, but neuroscience *per se* does not adjudicate specific rules or laws that make up the superstructure on the neurobiological platform. For that, we, as a collective, still need negotiation, compromise, good sense, and practical wisdom.**

could be split by surgically separating the hemispheres was a totally unexpected and completely stunning result. Dualists everywhere shuddered in their boots.

The ancient problems that have vexed philosophers – how do we know things about the world, how do we make decisions, where do values come from, how does consciousness emerge – are fundamentally problems about mechanism: about how the nervous system is organized to perform these functions. Unlike David Hume in the eighteenth century, I was lucky to be alive when neuroscience was on the brink of catching a monumental wave. By the early 1970s, the developing techniques and methods in neuroscience lent promise to the apparently far-fetched idea that progress can be made on the nature of brain mechanisms for higher functions – memory and learning, decision-making and choice, sleep and consciousness. Skeptics abound, of course, especially in philosophy, but grand predictions of failure have tended to be scaled back to quiet mutterings. Neurophilosophy is thus at the interface of traditional philosophy on the one hand and neuroscience on the other, linking also to genetics, experimental psychology, anthropology, and ethology.

In this context I want to mention a discovery-constellation that stands out as having unexpected relevance to philosophy, and to moral philosophy in particular. The imme-

diately relevant is to Socrates’ abiding question: where do moral values come from?

Let me give the background first. Surprisingly, the evolutionary development that led to mammalian and bird styles of sociality, including what we might call morality, was all about food – not about altruism *per se*. When warm-blooded animals first appeared, they enjoyed a masterful advantage over their cold-blooded competitors: they could forage at night when the warmth of the sun was absent, perhaps even feeding on sluggish cold-blooded reptiles awaiting the sun’s warmth to get them going. A disadvantage had to be overcome: gram for gram, the warm-blooded creature has to eat ten times as much. Changes accordingly emerged in body and brain of the warm-blooded to enhance survival: females produced fewer offspring, and the offspring were prodigious learners. Scaling up learning was accomplished by arranging for infants to be born with highly immature brains. After birth, these learning-ready brains could tune themselves up to whatever causal circumstance they happened to be born into. This essentially involved extending on a grand scale existing mechanisms for learning. As a strategy, this was a game-changer, and it depended on a massive supply of highly organized nerve cells. Thus gene modification produced the neocortex, a kind of soft-tissue computer in birds and mammals that overlies and con-

nects with the ancient structures embodying motivation, drives, and emotions.

The downside of this strategy for expanding cleverness is that infant mammals are pitifully dependent and easy prey. The solution to their survival? Rig it so that a mature animal cares for the infants until independence. Changing maternal brains to be caring brains was easy. Essentially, self-survival mechanisms were modified so that the ambit of *me* extended to *me-and-mine*. Just as the mature rat is wired to care for her own food and safety, so she is wired to care for the food and safety of her pups. Both mother and babies feel pain when separated and pleasure when reunited. They are bonded, and the bonding is embodied in neural circuitry. Is the love we feel real? Yes, indeed. It is as real as anything the brain does, such as remembering where home is, seeing the moon, or deciding to hide rather than run.

With related genetic changes, mates, kin, friends, and sometimes strangers came to be embraced in the sphere of *me-ness*; we nurture them, fight off threats to them, keep them safe. My brain knows these others are not *me*, but if I am attached to them, their plight fires up caring circuitry, motivating me to incur a cost to benefit the other.

Oxytocin, the ancient body-and-brain molecule, is at the hub of the intricate neural adaptations sustaining mammalian sociality. The fountainhead discovery was that injecting oxytocin into the brain of a virgin sheep brings on full maternal behavior – nudging a lamb to suckle, huddling over the lamb, and so forth. In some species, oxytocin injected into the brain of a male will also bring on species-typical fathering behavior. Not acting alone, oxytocin works with the opioids our brains manufacture, as well as with other hormones and signaling neurochemicals. Among its many roles, oxytocin decreases the stress response, making possible the friendly, trusting interactions typical of life in social mammals. I can let my guard

down when I know I am among trusted family and friends.

Although the strong similarities of all mammalian brains invites the conjecture that much of this story holds for humans, I should interject here that much less is known about oxytocin's role in the human brain than in the nonhuman brain. One problem has been to find ethically acceptable and experimentally meaningful ways to administer oxytocin. Unlike, say cocaine, which you can sniff up the nose and which readily crosses the blood-brain barrier, oxytocin does not readily cross and it de-natures very quickly.

**The ancient problems that have vexed philosophers – how do we know things about the world, how do we make decisions, where do values come from, how does consciousness emerge – are fundamentally problems about mechanism: about how the nervous system is organized to perform these functions.**

What of norms and rules, which are endemic to human morality? Other modifications to the ancient brain structures facilitate internalizing the social practices of the group. The center of this part of the story is the mammalian reward system, a system integrating the old basal ganglia with the new frontal cortex. As with evolutionarily older animals, the basal ganglia allow mammals to develop habits and skills that enhance their ability to compete. In mammals, some of these habits and skills structure *social* interactions with the upshot that certain plans are inhibited and other plans are put into action despite a cost. Generally, approval for an action is rewarding and feels good, whereas disapproval feels bad. We pick up appropriate social behavior by

imitating, sometimes quite unconsciously, our siblings and parents, thereby facilitating social harmony. As conditions change, solutions to social dilemmas may also change, and problem solving kicks in.

Something like a conscience about what is right and what is wrong emerges in the developing animal as its brain internalizes social norms and solves social problems.

In closing, may I emphasize that these neurobiological developments clarify the platform, and *only* the platform, for human morality. They help us understand how it is that we are social animals. As a science, neurobiology can help us understand why we

tend to have a moral conscience, but neuroscience *per se* does not adjudicate specific rules or laws that make up the superstructure on the neurobiological platform. For that, we, as a collective, still need negotiation, compromise, good sense, and practical wisdom.

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## Roland G. Fryer, Jr.

*Roland G. Fryer, Jr. is the Henry Lee Professor of Economics at Harvard University and faculty director of the Education Innovation Laboratory. He was elected a Fellow of the American Academy of Arts and Sciences in 2015.*

I am deeply grateful to be here today. It is particularly special for me to be among so many great social scientists, many of whom were at the University of Chicago around the same time as I was. The University of Chicago is a special place for me, because it was the first institution that treated economics like a full contact sport. I can remember – it was 15 years ago – when I was convinced that discrimination was running rampant in America and it was the cause for racial inequality in the country. I was in a 16-by-16 room on 62nd and Cottage Grove in Chicago. (I ended up there because I called the financial aid office and said, “I don’t have any money, and I don’t care about crime, so where do you think I should live?”) I had my Compaq laptop. It was a Thursday night, and we had Monday off because it was a holiday weekend, and I was going to destroy a paper by Derek Neal

**What we have done over the last few years, broadly in education and sociology and some in economics, is to try to understand what makes some models of educational production enormously efficient while others are not. And one of the great laboratories we use to do that is charter schools.**

and Bill Johnson, which basically said that discrimination is a second order, not a first order, problem for racial inequality in labor markets. I thought their results were completely crazy. I grew up in the South, and their assertion just didn’t seem possible. During that weekend, I learned the promise and the brilliance of social science as a way of using data to drive our decisions, and not just our anecdotes and our personal experience. I sat down with the data: 12,686 individuals from the National Longitudinal Survey of Youth, and damn it, they were right. I called my grandmother, who raised me, and I said, “Grandma, there’s just no way. I mean there’s just got to be discrimination in the world, but I looked at the data myself, and it’s not there. It’s not as important as we thought.” And she said to me, “Honey, I can just tell someone’s racist by looking at them.” I said, “Grandma, I wouldn’t go that far. I’m with you, but I don’t know about that.”

I really don’t have big thoughts about how social science can help shape America, but I will tell you a little bit about what we as social scientists, and particularly in economics, have been doing in terms of race over the last 15 years. What that paper showed and what I was trying to debunk is as follows: among full-time workers, there is a 30 percent difference between blacks and whites when you look at wages and a 190 percent difference if you look at employment. And so the question is: is that 30 percent because people are coming to the mar-

ket with the same set of skills, and the market is pricing those skills differently (which would be discrimination)? Or are people coming to the market with different sets of skills? What my good friends Derek Neal and Bill Johnson at the University of Virginia showed was that for the most part, people were coming to the market with different skills. Now it didn’t completely eliminate discrimination, but they thought it was a second order, not a first order, problem when it came to labor market inequality in America. And that was a big deal for me. The question then became: how do you ensure that kids who grow up in different zip codes will get to the market with the same amount of skill?

As befits an economist who was 27 when he had this idea, I was quite arrogant, and I thought this was so easy. All we have to do is pay kids to do well in school. If we change their incentives, we will change their behavior. We raised \$10 million and conducted randomized field trials with different incentive plans in 4 cities, 250 schools, and 20,000 children. In the end, the results were just okay. The real surprise was how angry people were that I would even suggest paying kids for performance.

In fact, not only did those experiments not turn out as I thought they would, I tried a similar experiment two weeks ago on my daughter, who is two-and-a-half. My wife, who is a mathematician, came to me and said, “Sweetie, I just can’t get Eleanor to use the potty. She’s two-and-a-half. We

have to figure this out.” I said, “Look, I’m the economist,” and so I bought the fancy Elmo potty and I put it in the bathroom. I went to my daughter with a handful of candies, and I said, “Sweetie, you’ll get a candy if you go to the restroom in that potty right over there.” She said, “I get one candy, Daddy, if I go there?” “One candy.” “Every time I go?” “Every time you go.” So 20 minutes later, she went over, and she went to the bathroom. She started, she finished, and she looked at me, and I looked at my wife, and I said, “The academy got that right, didn’t they?” And I was amazed. I thought wow, look at the power of economics, look at the power of incentives; I can’t believe my other experiments didn’t work. And about 20 minutes later, she said, “Daddy, do I still get the candy?” I said, “Yes, you do.” She went back over, she squeezed out what could possibly be about a teaspoon, she came back, she got the candy, she went back over, squeezed out another teaspoon, came back, got the candy, she went back. I said, this is terrible, no wonder those experiments didn’t work.

What we have done over the last few years, broadly in education and sociology and some in economics, is to try to understand what makes some models of educational production enormously efficient while others are not. And one of the great laboratories we use to do that is charter schools. The average charter school is no better than the average public school, but there is a distribution. There are some on the right that are doing phenomenal things in some of the most impoverished areas in America. There are some on the left of the distribution that should be closed immediately. And what is cool about them is that they allow you to look at the natural variation that exists in those schools, and try to link that with achievement. So just imagine the following equation: on the left-hand side, you have randomized lotteries, so you have treatment effects. You have a hun-

dred numbers that tell you the value of each school. On the right-hand side, myself and others have gone in and collected thousands of data points on how schools operate, trying to really estimate the education production function. What we found was that there were essentially five variables that explained 50 percent of the variance of what makes some schools good, and other schools not so good. I told you I was raised by my grandmother; she’s a wonderful woman. I always wanted to impress my grandmother, and I never quite got there. She just didn’t understand what this Harvard thing was about. She would ask me, “What do you do honey?” I would answer, “Well, I teach.” “How

**I believe in the power of social science to make people’s lives better. I have seen it happen in schools across the country. We really have an opportunity, and what better time to do it than now?**

often do you teach?” “A couple of classes a year.” She said, “Honey, that ain’t teaching.” And so I thought for sure at this point I would really impress my grandmother, and so I said to her, “Look, I know you’ve been a teacher for 37 years, but I think we just figured out what makes some schools good and other schools not so good.” And so she asked me to tell her what those things are. I told her about the five variables that we had found. And I’ll just give you an exact quote. She said – forgive her, she’s passed on now, but she was an old Southern woman – “Baby, they pay you for that shit?” “No, grandmother, not that much actually.”

What was interesting was that we took those five variables and we injected them in a randomized control trial in Houston, Texas. It involved taking 20 randomly picked schools, and removing the principals, removing 60 percent of the teachers, lengthening the school day, lengthening the school

year, bringing in data systems, and trying to set high expectations for kids who were in some of the worst performing schools not only in Houston, but in the country. In three years, the elementary schools were able to close the achievement gap; for the middle schools, it would take roughly five years. What it told us, and the reason it gave us some hope, was that it helped us understand that poverty is not destiny.

One of the things that really frustrated me, to be very frank about it, when I arrived here at Harvard in 2003, was that people would say not just that you come from public schools, but that you come from *poor* public schools. We would frankly make our-

selves feel better because we would say it’s possible. Yes, it’s possible. But it’s not probable. For a lot of the kids that I grew up with, and a lot of kids that I see in schools in places like Houston, Denver, Dallas, Washington, D.C., Chicago, and everywhere I go, it is possible. But it’s not probable. And that is where we need social science. I really believe in the power of social science to make people’s lives better. I have seen it happen in schools across the country. Our incentive experiment didn’t work, but we distributed \$10 million to twenty thousand kids across the country. I really believe in the power of what we do to make individuals’ lives better, because of our discipline, because of the data. We really have an opportunity, and what better time to do it than now?

Let’s talk about police use of force. This is something I have become obsessed with lately. Here we need data more than ever. In education the data exists. If you want to get

data from police, it is much more difficult. And, even when you get it – it comes in long narrative accounts of police-civilian interactions. So, you have to use some of the data techniques that my friend Matthew Gentzkow uses because the data are not in a usable format. I embedded myself this past summer in the Camden Police Department for three days. I went in a patrol car, responded to 911 calls. I have to admit, just like my beliefs about discrimination, I was wrong. I went in thinking the police should not be shooting anyone. I left thinking this is a very different set of situations than I originally thought. We have used this experience to free the data. And, simultaneously, there are police data initiatives across the country that are collecting data on police use of force, police shootings, and police arrests. This is precisely the type of thing that social science can shed light on. We need it. There are kids in communities like mine and others who need our help. And of course, governments can help, and philanthropists can help, but as I said before, I truly believe in the power of social science to make individuals' lives better. It has made my life better, and it has done a lot for people not only in America, but around the world. And so today, I am deeply appreciative of this honor to be inducted into the American Academy of Arts and Sciences. I never would have dreamed 20 years ago, debating with my grandmother about the causes of racial inequality in America on the plastic-covered furniture in her living room, that this was possible.

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### Sally Haslanger

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It is a great honor to be here and to be invited to speak. I come before you as a philosopher. That, in itself, is a source of great pride for me, for women have rarely been allowed the title of “philosopher” in the history of Western philosophy. The inclusion of women and members of other marginalized groups remains a struggle in the discipline.

Let me offer some examples. The best data we have suggest that there are approximately 13,000 academic philosophers in the United States, including graduate students and independent scholars. Of these, 156 are Black, and 55 of them are Black women. Of the 10,000 employed philosophy faculty, we think that roughly 17 percent are women in tenured or tenure track positions, and fewer than 30 are Black women. These numbers are staggeringly low and, aside from physics, are plausibly the lowest in the academy.

There are problems across the board, but philosophy is an outlier.

I believe that these low numbers indicate that the academic world is not a genuine meritocracy. But I'm not going to talk about that. (I hope that is sufficiently obvious.) I am going to talk about diversity. I know that for many, this is a very tired topic. But I'm hoping that it will enable us to reflect on our collective efforts to understand ourselves and the world, and philosophy's place in it.

It is striking that diversity is a problem in philosophy because philosophy is a discipline within the humanities. It is striking for two reasons. First, most of the humanities recognized the importance of inclusion decades ago: women, the working class, people of color, and those from other nations and speaking other languages have authored brilliant works, have created cultures within and intertwined with ours. Interdisciplinary work, for example, in women's and gender studies, African American studies, LGBT studies, disability studies, and other area studies, has engaged the disciplines to transform their methodologies and disrupt their canons. This has prompted a glorious expansion of inquiry in the arts and humanities, full of energy and creativity. Philosophy is so far behind. Why have we not been part of this?

Second, philosophy's mandate is to offer tools of thought, to reflect on the nature of being, knowledge, language, justice, goodness, and beauty. As a humanistic discipline, we seek (cultural) self-understanding, but in philosophy we also undertake normative inquiry into how we *ought* to think and live. How can we plausibly undertake this by consulting only (or mostly) the introspections of a few, especially when the few are those who are in every way culturally privileged? Who, upon reflection, would trust the introspections of any dominant group as a basis for inquiry into how we ought to understand and organize ourselves? The

problem is that knowers are socially situated and, as such, are vulnerable to epistemic bias. Conversations with the like-minded are not a reliable way to discover or correct for such bias.

One explanation of these two striking features is that philosophy's domain of inquiry is not the actual, but *the ideal*. Philosophers are not concerned with the messy practices of knowledge production, but with the criteria for knowledge. We are well aware that our world is ridden with injustice, but to address this issue we seek to know what justice is. Inquiry into the ideal depends on our capacity to abstract away from our particular circumstances, to set aside partial and parochial assumptions. If we are capable of this abstraction – and exercises to develop this ability are a crucial part of philosophical training – then diversity looks much less important. We are social beings, but social beings capable of recognizing ourselves as such, and taking that into account.

## **Abstraction is at the core of any systematic inquiry and it is crucial to our ability to live together. How would we manage if we couldn't abstract from our own particular experience in order to find common ground with others?**

Such a defense of philosophy's persistent social homogeneity may seem hopelessly naive. But it points to something important. I grant we should resist the epistemic goal of "aperspectivity," a view from nowhere. I am unwilling, however, to reject the possibility of inquiry that abstracts from our individual social positions. Abstraction is at the core of any systematic inquiry. No adequate theory is a report of little fact after little fact. And abstraction is crucial to our ability to live together. How would we manage if we couldn't abstract from our own particular

experience in order to find common ground with others? Acknowledging the situatedness of inquiry does not leave us with only interesting observations from different vantage points.

Abstraction is too thin a characterization of what is really at stake, however. I may be able to abstract from my actual experience of lunch to consider lunch in general; lunch need not be soup or salad at midday, after all. But mere abstraction does not generate awareness of the full range of possibilities. I do not learn from abstraction that for some lunch consists of mealworms or grasshoppers. Others unlike us are an important source of information: grasshoppers are not only edible, but eaten, even enjoyed! The value of such information should not be downplayed. How and what we abstract *from* allows us to extend the range of our theory. But more importantly, it generates new questions: Why are they eating grasshoppers? Are grasshoppers nutritious? Why don't we

eat grasshoppers? How do they catch the grasshoppers? Who does the catching?

Notice that these questions are not only about the information we have gained, but are also about *us*: Why don't we eat grasshoppers? Taking difference seriously offers a glimmer of perspective on us. This is a moment of critical reflection. And critical reflection is at the heart of any search for knowledge. I have chosen an example of a social practice: lunch. But even if our inquiry is about tectonic plates or nanoparticles, an encounter with something radically new

prompts the question: why didn't we see this before? What else are we missing? How can we improve our practices of inquiry to avoid missing things like this again? These too are questions *about us* and offer opportunities for self-criticism.

So far I have suggested that although all knowers are situated, we need not be trapped in our parochial perspectives. We can abstract from what information is available to us; we can trust the testimony of others to gain new information; we can critically reflect on what we ask and how we process information. And at each stage, we benefit from serious engagement with others whose epistemic position is different from ours. The expansion of the arts and humanities demonstrates how much was neglected and how much more there is to know. Philosophy's lack of diversity is not only an injustice; it makes our work less credible. But it is easy to become complacent, even in the arts and humanities. Disciplines can incorporate new areas of research without achieving a critical stance.

In women's studies we describe a certain inadequate approach to diversity: Add women and stir. (This extends also to other groups.) Don't get me wrong. This can be a huge achievement. But adding spice to a recipe is not the same as asking: Why are we cooking this dish? How did we get these ingredients? Who is going hungry? Part of the value of diversity in the academy is this self-reflective, *critical* move. Feminist theorists have asked why economists and historians ignored women's work in the home; critical race theorists have asked why Black voices were not included in the canons of literature and philosophy. Of course, theory is inevitably selective. Attending to neglected phenomena is a first step. But critical inquiry poses a further reflective question: what is being revealed and what occluded by our methods? What matters, and why? What questions should we really be asking?

## When norms conflict, how do we choose between them? What counts as bias? What are the right criteria for knowledge?

Critical reflection is importantly value-laden. When I ask why we don't eat grasshoppers, I am not just looking for a sociological or anthropological explanation. I am also raising the possibility: Should we eat grasshoppers too? Diverse inquirers are in a position to challenge us: from their social position, different phenomena matter, different questions are pressing. (One doesn't need to be trained in a discipline to pose these challenges.) Being seriously confronted with another way of doing things, guided by different norms – whether in cuisine or inquiry – causes my own norms to be challenged. In order to gain the benefits of critical reflection, I must step back from my practices and engage in normative inquiry: how *should* we proceed? Is there a better way?

This takes us back to the philosophical questions: when norms conflict, how do we choose between them? What counts as bias? What are the right criteria for knowledge? I have argued that to answer these questions, diversity matters: having many diverse sources of information is good. Critical reflection prompted by exposure to unimagined alternatives is good. We must rely on others to challenge us, hold us accountable, and expand the possibilities worth considering. But this doesn't give us answers.

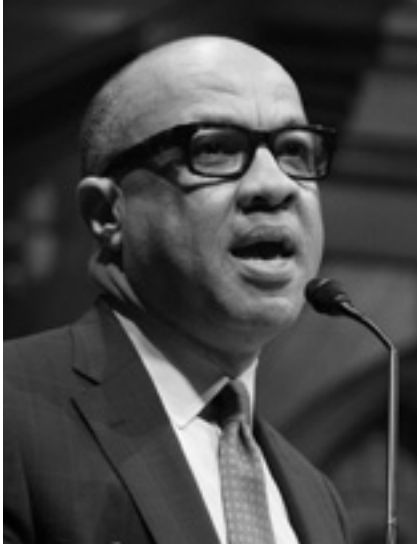
Of course, I can't answer the normative questions for you. Not because value is subjective and each of us must answer for ourselves. Rather, normative questions concern how *we* should organize ourselves to achieve *our* legitimate ends, be they truth or nutrition. This is not something that can be discovered individually or a priori. I cannot say how *we* should proceed and neither can you, only *we* can do that together. This

is an essentially collective enterprise. We might each start by inviting someone who seriously challenges us and our ways of doing things, perhaps someone from a marginalized group, to have lunch. (Don't assume that grasshoppers taste like chicken!) Ask them what matters to them, and why. Listen to them as if you have something to learn from them, because you do.

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## Darren Walker

*Darren Walker is President of the Ford Foundation. He was elected a Fellow of the American Academy of Arts and Sciences in 2015.*

Good afternoon. I would like to thank my friends, Jonathan Fanton and Don Radel. And as the expression goes, I would like to thank the academy!

I am humbled and honored to join you, and to accept your induction into the venerated ranks of the American Academy of Arts and Sciences. I must say, this is a moment made all the more humbling by dint of the distinguished colleagues and friends with whom I share this day: my fellow inductees.

My journey to this hallowed hall began in a small, segregated Louisiana town—fifty-some years ago—where I was born in a charity hospital to a single mother. As I got older, my mother realized that a community poisoned by poverty and prejudice was not a place of opportunity for my sister and me. So, we moved to Texas—to Ames, population 1,400—where we had family.

We lived in a narrow, shotgun house. My mom studied to become a nurse's assistant, a job she worked with pride and dignity for

**Across the country and around the world, we face a crisis of inequality – what I consider the existential threat of our time. Inequality – in all its forms: economic, social, political, racial, gender – compounds upon itself. Because of widening gaps, more people are slipping through the cracks, falling further and further behind.**

decades. We didn't have a lot. But we had enough.

I was in the inaugural Head Start program. I attended public schools, including the University of Texas, where I received scholarships endowed by wealthy, generous Texans—along with Pell Grants financed by the American people. The entire time I felt like everyone—my state, my country—was cheering me on.

After law school, I moved to New York, where I worked at a law firm, then an investment bank. I led a community organization in Harlem. And after many years working in community development, I joined the Rockefeller Foundation, then the Ford Foundation—the institution that I am now privileged to serve.

Now, I share all of this not because I am special. I share this because it shows how America is special.

And while it is true that we have our share of problems, for much of my lifetime, America's social-mobility escalator has been moving, lifting people as high as their hard work and talent will take them.

But, today, that escalator is slowing to a crawl. For some, it has stopped completely. What does this say about America's future?

I worry and despair that in the years ahead stories like mine will be far less likely. And the reason, in a word, is inequality.

Across the country and around the world, we face a crisis of inequality—what I consider

the existential threat of our time. Inequality—in all its forms: economic, social, political, racial, gender—compounds upon itself. Because of widening gaps, more people are slipping through the cracks, falling further and further behind.

We have seen the manifestations of inequality all across our society—whether you are looking at overrepresented populations in our jails and prisons, or underrepresented ones in our boardrooms and C-suites. We have read about it in the opinion pages and in best-selling books. We have felt its asphyxiating effect on our democracy.

I am deeply unsettled—deeply troubled—by all of this. I am unsettled because I was visiting with a prominent university president recently who voiced appreciation for an essay I wrote on inequality. I suggested that it would be helpful for him to also write and speak about inequality, and he replied that he couldn't risk offending his rich trustees and donors.

So, it is unsettling when leaders of institutions of higher education—which undergird our democratic society—cancel themselves on justice and fairness because they are afraid of offending the privileged.

And as someone who benefits from great privilege—in a room replete with people who have benefited from great privilege—I think about my obligations to earn this privilege; to interrogate my own privilege; and to ask myself: how do I use my privilege as a tool to

address, rather than compound, the inequality which makes my privilege possible.

Of course, this obligation is not new. A century and a quarter ago, the industrialist Andrew Carnegie found himself the beneficiary of the American dream. This son of poor immigrants had risen to become one of the wealthiest men in the world.

In 1889, Carnegie reflected on these things in an essay we now refer to as the Gospel of Wealth. He wrote, “Rich men should be thankful for one inestimable boon. They have it in their power” to organize “benefactions from which the masses of their fellows will derive lasting advantage, and thus dignify their own lives.”

must not cause the philanthropist to overlook the circumstances of economic injustice which make philanthropy necessary.”

To me, Dr. King’s words are my North Star – a guiding light. He challenges us to assess and address underlying structures and systems, to uproot the root causes of suffering and injustice, to not “overlook the circumstances” that make our work necessary, all with a love of country that is unwavering and unstinting.

I am an optimist because of institutions like the Academy that oxygenate our democracy. For one thing, we know so much more than we did 125 years ago. We have so much knowledge – in part because of the

This is the work of our generation. And I am proud to be on the journey with so many of you, members of the American Academy of Arts and Sciences. ■

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## **While it is true that we have our share of problems, for much of my lifetime, America’s social-mobility escalator has been moving, lifting people as high as their hard work and talent will take them. But, today, that escalator is slowing to a crawl. For some, it has stopped completely. What does this say about America’s future?**

It is worth remembering, too, that Carnegie articulated his philosophy during a time when inequality had reached unprecedented levels in the United States. And in our own era of rising inequality, we must openly acknowledge – and confront – a tension inherent in our economic, political, and social systems.

This tension is plain to see: Our systems in America perpetuate vast differences in privilege, and then task the privileged – all of us – with improving the systems that benefit us.

As a foundation president, my thinking on this issue has been shaped by Dr. Martin Luther King, Jr. About philanthropy he wrote, “Philanthropy is commendable. . . . But it

work of this Academy – and this knowledge compels and directs our action.

All of my life, I have benefited from – and learned from – the generosity of privileged people who understood their obligations and the pressure that comes with their privilege.

It will take all of us embodying this spirit – actively working, attentively questioning – to address the fundamental barriers to opportunity for too many Americans. It will take all of us remembering that our greatest privilege – our “inestimable boon” – is our opportunity to repair our nation’s fabric in the service of human dignity and justice for all.

# On Being an International Criminal Judge

Judge Theodor Meron

**I**n 2001, I was elected by the United Nations General Assembly to the United Nations International Criminal Tribunal for the former Yugoslavia (ICTY). At the age of 71, I thus found myself starting a new career: as an international criminal judge.

For a person who was catapulted to an international criminal court after a quarter of a century of teaching at the NYU School of Law, the change was momentous, even existential. Academic habits learned over the years – from obsessing over footnotes on abstruse questions to drawing analogies from across the universe of international law – had rapidly to yield to a new way of thinking and a laser-like focus on the immediate facts and the law of the case. I had to move from the luxury of contemplating theoretical questions and advancing bold ideas about the state of the law to agonizing over the justice of convicting or acquitting a person charged with the gravest crimes known to humanity and heeding principles of judicial restraint and economy in my writing. And I had to forsake the comfort gained from circulating drafts to academic peers and learning from their comments, and follow instead a relatively cloistered decision-making process in which, save at a hearing or in an eventual judicial opinion, one may share one's thoughts and concerns only with a few fellow judges and a law clerk or two.

My experience as an international criminal judge has been exhausting at times. It has been disquieting, frustrating, and, indeed, solitary. Yet, my years on the appeals bench or as a president (or chief justice) of the court have also been extraordinarily exciting and rewarding. And there is absolutely nothing I would exchange these years for.

The kind of intellectual overhaul I experienced in joining the international judiciary may be common for many of those who become judges in national courts as well, particularly if they have previously followed a different career path. And indeed, there is much about being a judge at an international criminal court that is similar to the experience of serving in the criminal courts at the national level. Like judges in national courts, an international criminal judge hears argument, sifts evidence, rules on diverse motions, considers novel questions of law, drafts decisions and judgments, and deliberates on verdicts and sentences. Like their counterparts in domestic systems, international criminal judges must put the fairness of the proceedings at the center of all that they do and be guided

by their commitment to judicial independence, to the judicial process's transparent and public nature, and to the importance of reasoned judicial decisions.

In other respects, however, the mission and work of an international criminal judge are different – and unique – from that of his or her national colleagues.

At the most basic level, the cases tried by an international criminal judge are unparalleled in evidentiary and geographic scope and scale and involve alleged crimes almost never prosecuted on a national level, such as genocide. An international criminal judge does not have the comfort of applying a penal code of long standing and supported by a gloss of interpretative precedent but must rely instead on typically skeletal statutes. Hence, to satisfy the principle of legality, international criminal judges at the ICTY, for instance, have had to ground their rulings in customary international law, the identification of which – due to customary law's often indeterminate nature – requires a judge to exercise both discretion and creativity, while resisting any possible drift toward progressive law-making.

An international criminal judge also cannot take for granted that his or her fellow judges, the advocates who come before them, or the public at large share a common understanding about how the law or legal procedures should be understood or, indeed, how a case should be managed. Judges trained in the common law and those trained in civil law may value legal precedents and their import differently, for example, and this difference may impact how the judges approach each new proposed ruling. Procedural and evidentiary rules, moreover, have to be developed and wielded based on the harmonization of diverse national precedents, legal traditions, and a variety of models: no small challenge.

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And even though the accused who come before international criminal courts are always tried as individuals, the work of those courts and the fates of the individual accused are often taken to be emblematic of broader political considerations. More than anything else, it is this broader political and historical context in which international criminal judges work – the conditions in which the court was created, the sensitive and often horrifying nature of the allegations at stake, the rank or seniority of those who typically stand accused, the ongoing struggles among ethnic and national groups fighting for the legitimization of their own historical narrative, the conflicting visions of rights and wrongs, and the competing claims of victimhood – that explains the unique nature of an international criminal judge’s professional environment.

Given this context, it is perhaps inevitable that international criminal courts and their judges will face criticism for particular rulings. Of course, the right to publicly express disagreement with a judicial decision is an integral part of a free society and a free press. And just as obviously, judges cannot cave in to pressure, nor be swayed in any way by public sentiment or critiques. Extra-judicial considerations must remain outside a judge’s decisional ambit, even at the cost of risking non-reelection to judicial posts in courts where such reelection is possible. Yet criticism can nonetheless have a corrosive effect on the credibility of a court, which risks not simply damaging perceptions of the court but undermining the aims of the court, and of international justice, more broadly.

Some criticism may reflect a lack of understanding of the ruling at issue or be driven by partisan concerns. But other criticism may come from those with the greatest hopes of and for international criminal justice and the judges entrusted with carrying it out. Indeed, international criminal judges must often carry out their work at the intersection of a myriad of strongly held and sometimes incompatible expectations about what role an international criminal court should play.

Some stakeholders, for instance, look to international criminal courts to establish the “truth” of a particular horrific event or to create a definitive historic record. When the court’s judgment fails to agree with an expected narrative of guilt or to find that a specific crime attributed to a particular individual has been committed by him or her, the claim is made that the court itself or the judges involved have failed in their mission.

There is no doubt that the quantum of evidence collected in relation to a case is often extraordinary and a judgment compiling such evidence can offer a detailed record of particular events. Moreover, for jurists coming from the civil law tradition with its investigating magistrates, truth-seeking may be seen as an essential component

of international criminal justice more, perhaps, than in the common law with its adversarial system.

But we must be careful to recall what is the core mandate of an international criminal court: it is to try individuals within a governing legal framework and to determine whether – given the specific evidence presented and admitted by the court – an individual’s accused responsibility for international crimes has been established beyond reasonable doubt. The demands of due process, the substantive legal requirements, and the precise nature of the evidence necessarily constrain the court’s findings in a way that a more free-ranging inquiry outside of the judicial process would not. And importantly, these same factors also permit different conclusions to be reached in different cases, meaning that responsibility for a crime may be found beyond reasonable doubt in one case while evidence of the same crime may be found insufficient in another.

Other stakeholders may look to international criminal courts – and to their judges – to bring about peace and post-conflict reconciliation, as indeed the United Nations Security Council and other bodies have at times suggested in establishing such courts. For those who believe that international criminal courts are mandated to promote peace and reconciliation, international criminal justice will almost invariably be found wanting where there is no evidence of any such impact or where rulings are thought to be counter-productive to reconciliatory aims.

Trying those accused of serious violations of international law in a public, fair, and careful way may have a beneficial impact on the restoration and maintenance of peace in an area previously torn asunder by conflict. But these salutary effects should not be confused with the narrow mandate of an international criminal court or its judges: to try those accused in accordance to the law. Were it otherwise – were international criminal courts responsible, even just in part, for ensuring reconciliation – the fairness of their proceedings would, almost inevitably, be put in doubt, as when the perceived interests of reconciliation would weigh in favor of a particular conviction or acquittal. Legal principle may not be trumped by an extraneous purpose, however desirable that purpose may be.

Finally, one of the most frequently voiced expectations is that international criminal courts should give victims justice. The idea that international criminal justice is done for the victims is popular, just as it is contested. It risks pitting the goal of many victims to ensure punishment of and retribution against those whom they believe to have committed crimes on the one hand against the rule of law guarantees of fairness, impartiality, and due process on the other. If one of the individuals accused of atrocities, and particularly one who is a political or military leader, is acquitted, or if the prosecution declines to pursue

charges, these decisions are sometimes viewed as a failure of international criminal justice.

But let us be clear. The true failure of international criminal justice would be if convictions or acquittals would be issued without support of law and evidence. If anything, occasional acquittals can be a sign of a mature and independent legal system and of a court that is focused on the narrow judicial mandate of trying those charged, rather than on attempting to satisfy the often conflicting expectations of diverse stakeholders. Even as we sympathize with the sentiments of victims, the overarching obligation of a criminal judge – whether at the national or the international level – is to respect the fundamental principles of the rule of law, a concept still more fragile in international than in most domestic jurisdictions. It is through affirming the importance of courts and due process – not simply in times of peace but in war and conflict and their aftermath – that we ensure that it is the law, and not the rifle and vengeance, that rules. And this, to my mind, is the animating principle at the very heart of international justice, and the principle that has been at the center of my work for nearly a decade and a half as an international criminal judge.

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# Spanish in the World

Rolena Adorno

When the American Academy of Arts and Sciences answered a bipartisan request from the United States Congress to assess the state of the humanities and social sciences, the Academy produced a major report titled *The Heart of the Matter*. To meet the goal to “equip the nation for leadership in an interconnected world,”<sup>1</sup> it recommended the promotion of language learning at all educational levels. The Academy project also resulted in a film on the role of the humanities and social sciences in American life. In seven brief minutes, each member of the star-studded cast of “The Heart of the Matter” ruminates briefly on the humanities, what they mean, and where we would be without them. The report and the film are available online: if the report is meant for our deans, the film merits viewing in our classrooms.

In response to the Academy’s promotion of language learning, and as a lifelong student and scholar of Hispanic literatures and cultures (though not by virtue of ethnic heritage), I offer an abbreviated version of the remarks I made at the 130th Modern Language Association Annual Convention on January 10, 2015<sup>2</sup>:

When the existence of this Western Hemisphere was first announced to Europe, it was done in Spanish. Quickly translated into Latin and hurriedly published, Christopher Columbus’s 1493 “Letter of Discovery,” as it has been called, was as much a world event as the remarkable discoveries it described and the promises it made to its readers at the Castilian royal court. Soon afterward, Spanish accounts of exploration and conquest were translated into Italian, English, French, German, and Dutch, as if to answer the question: “What *are* those people doing over there?” This hunger for what Spanish writings might reveal about the New World was not abated as the sixteenth century gave way to the seventeenth. In England, Richard Hakluyt’s protégé and successor Samuel Purchas (1577–1626) translated in *Purchas His Pilgrimes* (1625) further accounts of Spanish voyages of exploration, conquest, and settlement. And he added something new: he produced the first fruits of learning about America’s indigenous civilizations in the English language.

Purchas excerpted for the first time El Inca Garcilaso de la Vega’s *Comentarios reales de los Incas* (“Royal Commentaries of the Incas,” 1609, 1617), and, more remarkably, he produced an English version of a unique, mid-sixteenth-century native Mexican manuscript, known as the Codex Mendoza and preserved today in the Bodleian Library at Oxford University. In New Spain (today’s Mexico), the great creole polymath Carlos de Sigüenza y Góngora (1645–1700) later pored over Purchas’s massive four-volume compendium. He admired its native version of Aztec history, accompanied by painstakingly wrought woodcut reproductions of the Mexican hieroglyphics that had graced the original. The achievement prompted Sigüenza

to remark that Purchas’s work was worthy of “the most devoted lover of the homeland.”<sup>3</sup> But, of course, Purchas’s homeland was England. Purchas, the Anglican minister, literary compiler, and translator, thus stands, for me, as the figure that triangulates three spheres of interest and influence: Spain, England, and the Americas. And here I mean “three-plus,” since Purchas included the ancient autochthonous Americas alongside the Euro-Americas of his day.

For Anglo-North American interest in Spanish language and culture, the tone was set by Thomas Jefferson, who understood that “the antient [*sic*] part of American history is written chiefly in Spanish.”<sup>4</sup> Jefferson helped institute the teaching of the modern languages, including Spanish, in 1780 at the College of William and Mary, and in 1819 when he founded the University of Virginia. Writing in 1787 and 1788 to promising young men in his circle, urging them to study the Spanish and Portuguese languages, Jefferson cited the value of such study for both practical and academic reasons. To the young South Carolinian John Rutledge, Jr., Jefferson wrote:

Our connections with the Spaniards and Portuguese must become every day more and more interesting, and I should think, the knowledge of their language[s], manners, and situation, might eventually and even probably become more useful to yourself and country than that of any other place you will have seen.<sup>5</sup>

And he added, presciently, “The womb of time is big with events to take place between us and them.” Indeed.

Today those prophecies have been fulfilled. We have gone “from Havana to Macondo” and beyond. (Witness President Obama’s Executive Order of December 17, 2014, that lifted some of the half-century-old restrictions on U.S. relations with Cuba.) The winds from Havana that blew on January 1, 1959, when Fidel Castro took over the island, and those that blew from the United States on January 3, 1961, when President Dwight D. Eisenhower closed the U.S. embassy in Havana and severed diplomatic relations, fanned the flames of U.S. interest in Latin America. Followed by the CIA-inspired Bay of Pigs invasion of Cuba in the first months of John F. Kennedy’s presidency, in April 1961, and the Cuban Missile Crisis, in October

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1962, these political watersheds also foreshadowed literary events of great purchase in Latin America.<sup>6</sup>

The Latin American novels of the mid-twentieth century and their international translations – the “Boom” of Latin American literature – were accompanied by the ascent of the teaching of the Spanish language in the United States,<sup>7</sup> and it has been accelerated by the growing Latino presence in the United States and, in the academy, by students’ practical interests as well as their intellectual and cultural engagements. On today’s Latino America, its history, and its promise, I recommend the three-part, six-hour documentary series, *Latino Americans: The 500-Year Legacy that Shaped a Nation*, which chronicles the centuries-long history of today’s Latinos and their ancestors on the North American continent. This project complements another great documentary series, *Created Equal: America’s Civil Rights Struggle*, which traces African American history in the United States from the 1830s to the 1960s. Both projects received support from the National Endowment for the Humanities through its Division of Public Programs, which funded the documentary films and helped design the projects that are taking community-based discussions to sites across the country.

Like *Latino Americans* and *Created Equal*, the Academy’s film “The Heart of the Matter” offers an excellent antidote to common misperceptions, in this case, the notion that the STEM subjects are the humanities’ natural antagonists. We are more likely to find the forces of antagonism within ourselves, in our occasional indifference, every time (when and if) we fail to engage students who have walked into our classrooms from beyond the precincts of our humanities disciplines. We all know how intellectually open such students tend to be, unfettered by unhelpful, intra-humanities biases. These students often ask the questions that their humanities-student peers fail to ask. I cannot count the number of times I have heard myself thinking, as I ponder a response to an outside-the-humanities-box student intervention, “Hmmm, I never thought of that.” The idea of reaching students outside humanities majors in courses of literary, historical, and cultural substance – and doing so in the language native to those traditions, in this case, in Spanish – is a worthy pursuit, not only as a service (which, in my view, is *not* a bad word), but also as an inherent aspect of our vocation.

Perhaps we in Spanish can do this more easily than other modern languages because of the ubiquity in the United States of student linguistic competence, as well as the interests of students who do not possess it. If so, we are privileged, but it also gives us a greater responsibility: In the fields of Hispanic Studies, we must refuse to give up teaching undergraduate and graduate courses in the language, that is, in Spanish. (There are institutional pressures that would have us do so.) The English language is ubiquitous, but it is neither

universal nor a transparent, non-distorting lens through which all other modern languages can pass, in translation, without loss.

I turn again to Carlos de Sigüenza y Góngora. When Sigüenza called Purchas’s translation of the Codex Mendoza a worthy achievement, he meant that its publication, though in English, rescued it from oblivion, preserved it for posterity. Sigüenza was himself one of the early, great scholars of pre-Columbian Mexican antiquities, and he sought to bring the pre-Columbian experience of ancient Mexico out of the shadows of myth and into the light of history. His salute to Purchas anticipated the tribute that the great Prussian explorer and scholar of the Americas, Alexander von Humboldt (1769–1859), would make to the memory of Sigüenza.

Journeying to New Spain in the last decades before it became an independent Mexico, Humboldt attempted to locate the Mexican manuscripts that Sigüenza had collected and studied. Humboldt followed the footsteps of the Italian traveler and compiler Giovanni Gemelli Careri (1651–1725), the author of *Giro del mondo* (1699–1700), who had seen the manuscripts, and perhaps copied some of them under Sigüenza’s supervision. Although Humboldt was unsuccessful in his quest, he was able to examine the then-greatest extant collection of ancient Mexican manuscripts available. Recalling his anticipation, Humboldt later wrote, in French, that he imagined, and could experience in his own right, the emotion that Gemelli Careri must have felt when, more than a century earlier, the Italian had made the pilgrimage that ended at Sigüenza’s door.

I have presented this imaginary, but not unreal, in fact, virtual, conversation-over-time because it was carried out from the vantage points of several cultural and linguistic traditions: the Renaissance English, the Baroque Spanish, Italian, and creole Spanish-American, and the Enlightenment German and French. All were united in the pursuit of pre-Columbian antiquities, and all their exchanges were brought together through the Spanish language, the earliest European conduit and interpreter of pre-Columbian indigenous traditions of the Americas. This cultural historical litany exemplifies the continuity of culture that characterizes, in no small measure, the life of the humanities and, in particular, the role of the Spanish language within it.

Over the course of time, Spanish – in this New World, on the Iberian Peninsula in the Old, and in Asia in the East – has become one of the world’s most culturally rich languages. It contains within it the traces of those many ongoing, diverse cultures that it has touched and the new formulations with which it interacts and which continually renew it. The great Spanish humanist Hernán Pérez de Oliva (ca. 1494–1531), who helped forge vernacular Spanish as a language of high culture and learning, marveled in 1524 at the place of Spain in the world: “We used to occupy the ends of

the earth, and now we find ourselves in the middle of it, thanks to a twist of fortune such as never before has been seen.”<sup>8</sup> We can say the same today about the Spanish language. If any of the professional practitioners of the modern languages can make good on the Academy’s goal of promoting language learning, it is incumbent on us in Spanish to do so.

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#### ENDNOTES

1. American Academy of Arts and Sciences, *The Heart of the Matter* (Cambridge, Mass.: American Academy of Arts and Sciences, 2013), 12; online at <http://www.amacad.org>.
  2. Rolena Adorno, “Spanish in the World,” *Profession*, <https://profession.commons.mla.org/2015/04/01/spanish-in-the-world>.
  3. Carlos de Sigüenza y Góngora, *Teatro de virtudes políticas*, in *Seis obras de Carlos de Sigüenza y Góngora*, introd. Irving A Leonard, ed. William C. Bryant (Caracas: Biblioteca Ayacucho, 1984), 181–182, my translation.
  4. Thomas Jefferson, “To Thomas Mann Randolph, Jr.,” July 6, 1787, in *The Papers of Thomas Jefferson, Volume 11, 1 January to 6 August 1787*, ed. Julian P. Boyd (Princeton: Princeton University Press, 1955), 558.
  5. Thomas Jefferson, “To John Rutledge, Jr.,” July 13, 1788, in *The Papers of Thomas Jefferson, Volume 13, March to 7 October 1788*, ed. Julian P. Boyd (Princeton: Princeton University Press, 1956), 358.
  6. Roberto González Echevarría, *Modern Latin American Literature: A Very Short Introduction* (New York: Oxford University Press, 2012), 99–102.
  7. Rolena Adorno, “Havana and Macondo: The Humanities in U.S. Latin American Studies, 1940–2000,” in *The Humanities and the Dynamics of Inclusion Since World War II*, ed. David A. Hollinger (Baltimore: Johns Hopkins University Press, 2006), 376–378, 383–384.
  8. Quoted in Rolena Adorno, *Colonial Latin American Literature: A Very Short Introduction* (Oxford: Oxford University Press, 2011), 11.
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## Building Strong Bonds

Joan B. Silk

**A**nimals live in a world of limited resources. When resources that affect survival and reproduction – food, water, mates, nest sites, burrows, and so on – are scarce, conflicts of interest arise. Natural selection favors traits that enhance success in competition, and competitive pressures are responsible for some of the most spectacular adaptations that we see in nature: the peacock’s tail, the many variations in the beaks of Darwin’s finches, the ants’ complex colonies, and the baboon’s intimidating canines. Even our large and powerful brains may be the legacy of millions of years of maneuvering for advantage in competitive situations. A growing body of evidence suggests that social bonds may also help animals compete effectively and cope with the consequences of conflict. Some species, including many primates, form coalitions in contests with rivals. A variety of social tactics, including grooming, reproductive concessions, and tolerance at feeding sites, may be used to strengthen relationships with valued allies. The presence of reliable allies may protect animals from harassment and reduce stress.

This general argument implies that sociality will have fitness consequences for the individual. However, there were few efforts to actually test this idea, partly because it seemed unlikely that we would be able to link the short-term benefits that individuals derive from social interactions, such as grooming or greetings, to long-term differences in their fitness. However, as my friend, Lynn Fairbanks, pointed out to me over lunch one day, we ought to look for connections between social bonds and fitness outcomes.

Savanna baboons seemed like ideal candidates for this kind of analysis. Primatologists have been studying baboons for decades, so we already know a lot about their social organization, mating systems, and behavior. Baboons form large multi-male, multi-female groups from which males disperse at puberty. Females remain in their natal group throughout their lives and form stable dominance hierarchies, in which related females occupy adjacent ranks. Coalitionary support plays an important role in rank acquisition, and might also play a role in maintaining dominance rank. Females spend a good part of their day grooming, a behavior that is thought to cement social bonds.

I proposed an analysis of the structure and function of social bonds among female baboons to my friends, Jeanne Altmann and Susan Alberts, directors of the Amboseli Baboon Research Project (ABRP), which has been monitoring yellow baboons, *Papio cynocephalus*, in the Amboseli basin of Kenya since the early 1970s. I had worked in Amboseli in the early 1980s and knew that the ABRP conducted systematic observations of female social behavior and collected information about various aspects of female reproductive behavior. I suggested that we put these two data sets together. Jeanne and Susan agreed to collaborate on this project, and soon hundreds

of thousands of lines of behavioral data representing more than 100 females were sitting on my hard disk.

The first step was to quantify social relationships. Social relationships are abstractions that represent the history of interactions among individuals. We needed to operationalize this concept. Susan had devised an index of “social integration” to characterize the social disposition of Amboseli males, and we modified this procedure for our analyses of females. We used information about the rates of grooming and association to create a composite sociality index for each female. The next step was to evaluate female reproductive success. Infant survival is an important source of variation in lifetime fitness among females in the Amboseli population, so we calculated the proportion of each female’s infants that survived their first year of life.

We found that females that were more socially integrated into their groups had higher survivorship among their infants than females that were less socially integrated. Our results were exciting because they linked sociality with fitness consequences for the first time, and supported the hypothesis that social bonds may be an adaptive means to cope with competitive pressures.

Our findings prompted us to examine females’ social bonds more carefully. We found that females were most likely to form strong ties to close kin and peers who were likely to be their paternal half-sisters. Females also preferentially supported their relatives in agonistic contests. When we examined the distribution of grooming within dyads, we discovered that females with the strongest social bonds also had the most well-balanced grooming relationships. The long-term nature of the Amboseli project also let us explore the stability of females’ relationships across time. Mothers and daughters were quite likely to maintain very close ties for as long as they lived together in the group. In contrast, relationships with unrelated partners were typically ephemeral, with strong relationships existing in one year, but not lasting until the next. Thus, we found that

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females in Amboseli form strong, supportive, well-balanced, and enduring relationships with selected partners.

Some questions arose as these findings were published and publicized. Some colleagues suggested that the causal arrow might run in the other direction. Baboon females are fascinated by other females' infants, and cluster around mothers of newborns so that they can touch, sniff, and groom these infants. Perhaps our results reflect elevated levels of sociality for mothers of surviving infants rather than benefits derived from sociality. I also wondered whether this might be a case of beginner's luck. Would the results hold up in other baboon populations?

I was lucky to be invited to dig into another rich body of data by my friends Dorothy Cheney and Robert Seyfarth, who directed a long-term study of chacma baboons, *Papio ursinus*, in the Moremi Reserve of Botswana. Robert and Dorothy had invited me to join them in the field as they began their project in the early 1990s. A number of postdoctoral fellows who worked with them in subsequent years (Jacinta Beehner, Thore Bergman, Cathy Crockford, Anne Engh, Liza Moscovice, and Roman Wittig) used the same data collection protocol that we had used, and kindly agreed to let me explore their data.

Dorothy pointed out that we could eliminate the “natal attraction” problem by simply excluding data from females when they had young infants in our analyses. We found striking similarities in the structure of social bonds among females in Amboseli and Moremi. Even more satisfying, however, were analyses that showed that the strength of females' social bonds was positively associated with the survival of their infants. Thus, for these two baboon populations, which live in very different ecological settings thousands of miles apart from each other, females form close social bonds and sociality seems to enhance female fitness.

We have begun to learn that baboons may not be exceptional in this way. Sociality is associated with higher reproductive success in female horses, house mice, and bottle-nosed dolphins and in male Assamese macaques. There is also abundant evidence that greater social integration is associated with reduced mortality and better physical and mental health in humans. These parallels suggest that the capacity to build strong bonds has been favored by natural selection for millions of years.

So, I offer this advice: make a date to go out for coffee with a friend. It will do you both good. ■

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Anubis baboons grooming.



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**Aziz Sancar** (University of North Carolina at Chapel Hill)

### National Medal of Science

**A. Paul Alivisatos** (Lawrence Berkeley National Laboratory)

**Michael Artin** (Massachusetts Institute of Technology)

**Albert Bandura** (Stanford University)

**Stanley Falkow** (Stanford University School of Medicine)

**Shirley Ann Jackson** (Rensselaer Polytechnic Institute)

**Rakesh K. Jain** (Harvard Medical School; Massachusetts General Hospital)

**Mary-Claire King** (University of Washington)

**Simon Levin** (Princeton University)

**Geraldine Richmond** (University of Oregon)

### National Medal of Technology and Innovation

**Joseph DeSimone** (University of North Carolina at Chapel Hill; North Carolina State University)

### National Medal of Arts, 2014

**John Baldessari** (John Baldessari Studio)

**Sally Field** (Beverly Hills, California)

**Ann Hamilton** (Ohio State University)

**Meredith Monk** (House Foundation for the Arts)

**Tobias Wolff** (Stanford University)

### National Humanities Medal, 2014

**Annie Dillard** (Key West, Florida)

**Rebecca Goldstein** (Harvard University)

**Vicki Ruiz** (University of California, Irvine)

**Alice Waters** (Chez Panisse)

### Presidential Medal of Freedom

**Itzhak Perlman** (New York, New York)

**Stephen Sondheim** (New York, New York)

**Steven Spielberg** (Amblin Entertainment, Inc. & DreamWorks SKG)

### Carnegie Medal of Philanthropy

**Paul G. Allen** (Vulcan, Inc.)

**Charles F. Feeney** (Atlantic Philanthropies)

**Hanne and Jeremy Grantham** (Grantham, Mayo, Van Otterloo & Co LLC)

**Joan and Irwin Jacobs** (Qualcomm, Inc.)

**David M. Rubenstein** (Carlyle Group)

### Other Awards

**Alan Alda** (New York, New York) is the recipient of the 2016 Public Welfare Medal of the National Academy of Sciences.

**A. Paul Alivisatos** (Lawrence Berkeley National Laboratory) is the recipient of the Tsinghua University Press-Springer Nano Research Award.

**Hans Belting** (Staatliche Hochschule für Gestaltung) was awarded the 2015 Balzan Prize.

**Stephen J. Benkovic** (Pennsylvania State University) has been elected a Fellow of the National Academy of Inventors.

**Charles Bernstein** (University of Pennsylvania) received the Münster International Poetry Prize and the Jannus Pannonius Grand Prize for Poetry.

**Wendell Berry** (Port Royal, Kentucky) received the Ivan Sandrof Lifetime Achievement Award from the National Book Critics Circle. He also received the 2016 Sidney Lanier Prize for Southern Literature, awarded by Mercer University's Center for Southern Studies.

**Robert J. Birgeneau** (University of California, Berkeley) is the recipient of the 2015 Darius and Susan Anderson Distinguished Service Award of the Institute of Governmental Studies at the University of California, Berkeley.

**George Breslauer** (University of California, Berkeley) is the recipient of the 2016 Clark Kerr Award for Distinguished Leadership in Higher Education.

**Maurizio Brunori** (Università degli Studi di Roma "La Sapienza") is the recipient of the 2016 Eraldo Antonini Award in Porphyrin Chemistry.

**Lewis Cantley** (Weill Cornell Medical College) is the recipient of the 2015 AACI Distinguished Scientist Award, given by the Association of American Cancer Institutes.

**Federico Capasso** (Harvard University) is a co-recipient of the 2015 Rumford Prize, awarded by the American Academy of Arts and Sciences. He shares the prize with **Alfred Cho** (Alcatel-Lucent's Bell Labs).

**Federico Capasso** (Harvard University) has been elected into the *Accademia Europaea*.

**Sean B. Carroll** (University of Wisconsin-Madison; Howard Hughes Medical Institute) was awarded The Rockefeller University's Lewis Thomas Prize for Writing about Science.

**Alfred Cho** (Alcatel-Lucent's Bell Labs) is a co-recipient of the 2015 Rumford Prize, awarded by the American Academy of Arts and Sciences. He shares the prize with **Federico Capasso** (Harvard University).

**Stephen Cook** (University of Toronto) received the BBVA Foundation Frontiers of Knowledge Award in the Information and Communication Technologies category.

**William Dally** (Stanford University; NVIDIA) received the Funai Achievement Award from the Information Processing Society of Japan.

**Ronald J. Daniels** (Johns Hopkins University) is a recipient of Carnegie Corporation's 2015 Academic Leadership Award.

**Douglas Diamond** (University of Chicago) is the 2015 recipient of the CME Group-MSRI Prize in Innovative Quantitative Applications.

**Stephen J. Elledge** (Harvard Medical School) is the recipient of the 2015 Albert Lasker Basic Medical Research Award. He shares the prize with **Evelyn M. Witkin** (Rutgers, The State University of New Jersey).

**Charles F. Feeney** (Atlantic Philanthropies) is the inaugural recipient of the Stead Medal in International Philanthropy, given by the Indiana University Lilly Family School of Philanthropy.

**Ben L. Feringa** (University of Groningen, The Netherlands) is the recipient of the 2015 Chemistry of the Future Solvay Prize.

**Christopher Field** (Stanford University; Carnegie Institution for Science) is the recipient of the 2015 Stephen H. Schneider Award for Outstanding Climate Science Communication.

**Cheryl Finley** (Cornell University; Academy Visiting Scholar, 2004–2005) was awarded a fellowship from the American Council of Learned Societies.

**G. David Forney, Jr.** (Massachusetts Institute of Technology) was awarded the 2016 Institute of Electrical and Electronics Medal of Honor.

**Herbert Gleiter** (Institute of Nanotechnology, Germany) was awarded the Cothenius Medal of the German National Academy of Sciences. He was also elected to the Academia Europaea, the European Academy of Sciences and Arts, and the EU Academy of Sciences.

**Jeffrey I. Gordon** (Washington University in St. Louis) is a recipient of the 2015 Keio Medical Science Prize, awarded by Keio University in Tokyo.

**Linda Greenhouse** (Yale University) delivered the 2015 William E. Massey Sr. Lectures in American Studies at Harvard University: three lectures under the title “Just a Journalist: Reflections on Journalism, Life, and the Spaces Between.”

**Jürgen Habermas** (University of Frankfurt, Germany) and **Charles Taylor** (McGill University) were awarded the John W. Kluge Prize for Achievement in the Study of Humanity, given by the Library of Congress.

**Helen H. Hobbs** (University of Texas Southwestern Medical Center) is a 2016 recipient of the Breakthrough Prize in Life Sciences. She was also awarded the 2015 Pearl Meister Greengard Prize given by The Rockefeller University.

**Randy Hulet** (Rice University) was awarded the 2016 Davison-Germer Prize in Atomic Physics by the American Physical Society.

**William L. Jorgensen** (Yale University) has received the 2015 Tetrahedron Prize for Creativity in Bioorganic and Medicinal Chemistry.

**David Karl** (University of Hawai‘i) was awarded the 2015 Balzan Prize.

**Mary-Claire King** (University of Washington) has been awarded the 2016 Szent-Györgyi Prize for Progress in Cancer Research.

**Nancy Kleckner** (Harvard University) has been awarded the Genetic Society of America’s Thomas Hunt Morgan Medal.

**Robert Langer** (Massachusetts Institute of Technology) was awarded the Queen Elizabeth Prize for Engineering.

**Stephen Leone** (University of California, Berkeley) delivered the 2016 Milton Kahn Annual Lecture, hosted by the University of New Mexico Department of Chemistry and Chemical Biology.

**Peter Lepage** (Cornell University) received the 2016 J.J. Sakurai Prize for Theoretical Particle Physics from the American Physical Society.

**Douglas N.C. Lin** (University of California, Santa Cruz) is the recipient of the 2015 Catherine Wolfe Bruce Gold Medal, given by the Astronomical Society of the Pacific.

**Gerald D. Mahan** (Pennsylvania State University) is the recipient of the 2015 Outstanding Achievement in Thermoelectrics Award, given by the International Thermoelectric Society.

**Tobin J. Marks** (Northwestern University) have been named a 2015 Fellow of the National Academy of Inventors.

**Gail Martin** (University of California, San Francisco) was elected as a Foreign Member of The Royal Society.

**Christopher McKee** (University of California, Berkeley) was awarded the 2016 Henry Norris Russell Lectureship by the American Astronomical Society.

**Joel Mokyr** (Northwestern University) was awarded the 2015 Balzan Prize.

**K.C. Nicolaou** (Rice University) is the recipient of the 2016 Wolf Prize in Chemistry. He shares the prize with **Stuart Schreiber** (Harvard University; Broad Institute).

**C. L. Max Nikias** (University of Southern California) is a recipient of Carnegie Corporation’s 2015 Academic Leadership Award.

**Emiko Ohnuki-Tierney** (University of Wisconsin-Madison) was awarded La médaille du Collège de France.

**Svante Pääbo** (Max-Planck-Institut für evolutionäre Anthropologie) is a recipient of the 2016 Breakthrough Prize in Life Sciences.

**Jeffrey D. Palmer** (Indiana University) has been awarded the McClintock Prize for Plant Genetics and Genome Studies by the Maize Genetics Executive Committee.

**Roger Perlmutter** (Merck) is the recipient of a PMWC Luminary Award.

**William Rawn** (William Rawn Associates, Architects, Inc.) received the 2015 National AIA Honor Award in Architecture for the Cambridge Public Library in Cambridge, Massachusetts.

**Keren Rice** (University of Toronto) was awarded the Pierre Chauveau Medal of the Royal Society of Canada.

**Robert Roeder** (The Rockefeller University) received the Herbert Tabor Research Award from the American Society for Biochemistry and Molecular Biology.

**Peter Salovey** (Yale University) is the recipient of the 2015 Outstanding Contribution Award by a Senior Professional from the Division of Health Psychology, American Psychological Association.

**Stuart Schreiber** (Harvard University; Broad Institute) is the recipient of the 2016 Wolf Prize in Chemistry. He shares the prize with **K.C. Nicolaou** (Rice University).

**Stephen Shectman** (Carnegie Institution for Science) is the recipient of the Maria and Eric Muhlmann Award from the Astronomical Society of the Pacific.

**Ralph Snyderman** (Duke University Medical Center) is the recipient of a PMWC Pioneer Award.

**Nahum Sonenberg** (McGill University) is the recipient of the Canadian Cancer Research Alliance’s Award for Outstanding Achievements in Cancer Research.

**Peter Stang** (University of Utah) received China’s 2015 International Science and Technology Cooperation Award.

**Alexander Szalay** (Johns Hopkins University) has been selected as the recipient of the 2015 IEEE Computer Society Sidney Fernbach Award.

**Charles Taylor** (McGill University) and **Jürgen Habermas** (University of Frankfurt, Germany) were awarded the John W. Kluge Prize for Achievement in the Study of Humanity, given by the Library of Congress.

**Mitsuko Uchida** (London, United Kingdom) is the recipient of the 2015 Praemium Imperiale for Music.

**Irving Weissman** (Stanford School of Medicine) is the recipient of a PMWC Pioneer Award.

**John Williams** (Los Angeles, California) received the 44th American Film Institute Life Achievement Award.

**Evelyn M. Witkin** (Rutgers, The State University of New Jersey) is the recipient of the 2015 Albert Lasker Basic Medical Research Award. She shares the prize with **Stephen J. Elledge** (Harvard Medical School).

**William Wood** (University of Colorado Boulder) has been awarded the Genetics Society of America’s Elizabeth W. Jones Award for Excellence in Education.

**Peidong Yang** (University of California, Berkeley) has been named a 2015 MacArthur Fellow.

**Leonard I. Zon** (Harvard Medical School; Boston Children’s Hospital) is the recipient of the 20th annual Alfred G. Knudson Award in Cancer Genetics from the National Cancer Institute.

## New Appointments

**A. Paul Alivisatos** (Lawrence Berkeley National Laboratory) has been appointed Vice Chancellor for Research at the University of California, Berkeley.

**Frances Arnold** (California Institute of Technology) was appointed to the Board of Directors of Illumina, Inc.

**Carolyn Bertozzi** (Stanford University) has been appointed to the Advisory Board of Catalent.



**Arthur Bienenstock** (Stanford University) was appointed to the Scientific Advisory Committee of the Supporters of Agricultural Research (SoAR) Foundation.

**Aaron Ciechanover** (Technion-Israel Institute of Technology) was appointed to the Scientific Advisory Board of BioLineRx Ltd.

**Mary Sue Coleman** (University of Michigan) was appointed President of the Association of American Universities.

**Nicholas M. Donofrio** (NMD Consulting, LLC) has been elected to the Board of Directors of the National Association of Corporate Directors.

**Elazer Edelman** (MIT; Harvard Medical School) has been appointed to the Board of Directors of Echo Therapeutics, Inc.

**Karl W. Eikenberry** (Stanford University) has been named Executive Director of Northwestern University's Buffett Institute for Global Studies.

**William Galston** (Brookings Institution) has been appointed Interim Director of the Brown Center on Education Policy at the Brookings Institution.

**Douglas Hanahan** (Swiss Federal Institute of Technology Lausanne) was appointed to the Scientific Advisory Board of Intensity Therapeutics, Inc.

**Steven Hyman** (Harvard University; Broad Institute) was appointed to the Board of Directors of Voyager Therapeutics, Inc.

**Peter Kareiva** (University of California, Los Angeles) was appointed Director of the UCLA Institute of the Environment and Sustainability.

**Louis Kunkel** (Harvard Medical School; Boston Children's Hospital) was appointed to the Strategic and Scientific Advisory Board of Sarepta Therapeutics.

**Lewis L. Lanier** (University of California, San Francisco) has been appointed to the Scientific Advisory Board of Five Prime Therapeutics, Inc.

**Reynold Levy** (Riverdale, New York) was appointed President of the Robin Hood Foundation.

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

**Elliot Meyerowitz** (California Institute of Technology) was appointed to the Scientific Advisory Committee of the Supporters of Agricultural Research (SoAR) Foundation.

**Cherry A. Murray** (Harvard University) was confirmed as Director of the Office of Science in the U.S. Department of Energy.

**Thomas J. Pritzker** (Hyatt Corporation) has been appointed Chairman of the CSIS Board of Trustees.

**David Rubenstein** (Carlyle Group) has been appointed to the Board of Trustees of the National Gallery of Art.

**Barbara Schaal** (Washington University in St. Louis) was appointed to the Scientific Advisory Committee of the Supporters of Agricultural Research (SoAR) Foundation.

**Robert D. Schreiber** (Washington University in St. Louis School of Medicine) was appointed co-editor-in-chief of *Cancer Immunology Research*.

**Thomas E. Shenk** (Princeton University) has been appointed to the Board of Directors of Vical Incorporated.

**Éva Tardos** (Cornell University) has been named Editor-in-Chief of the *Journal of the Association for Computing Machinery*.

**Shirley M. Tilghman** (Princeton University) has been named to the Harvard Corporation.

**Matthew Tirrell** (University of Chicago) has been named Deputy Laboratory Director for Science at Argonne National Laboratory.

**David R. Walt** (Tufts University) has been appointed to the Board of Directors of Cerulean Pharma Inc.

**A. Eugene Washington** (Duke University) has been named to the Boards of Directors for Kaiser Foundation Health Plan, Inc. and Kaiser Foundation Hospitals.

**Ernest J. Wilson III** (University of Southern California) has been elected to the Board of the California Wellness Foundation.

## Select Publications

### Poetry

**Linda Gregerson** (University of Michigan). *Prodigal: New and Selected Poems, 1976–2014*. Mariner Books, September 2015

**Rachel Hadas** (Rutgers University-Newark). *Talking to the Dead*. Spuyten Duyvil Press, June 2015

**Donald Hall** (Wilmot, New Hampshire). *The Selected Poems of Donald Hall*. Houghton Mifflin Harcourt, December 2015

### Fiction

**Anna Quindlen** (New York, New York). *Miller's Valley*. Random House, April 2016

**Jane Smiley** (Carmel Valley, California). *Golden Age*. Knopf, October 2015

### Nonfiction

**Roger Angell** (*New Yorker*). *This Old Man: All in Pieces*. Doubleday, November 2015

**John C. Avise** (University of California, Irvine). *Sketches of Nature: A Geneticist's Look at the Biological World During a Golden Era for Molecular Ecology*. Academic Press, October 2015

**Ben S. Bernanke** (Brookings Institution). *The Courage to Act: A Memoir of a Crisis and Its Aftermath*. W. W. Norton, October 2015

**Charles Bernstein** (University of Pennsylvania). *Pitch of Poetry*. University of Chicago Press, March 2016

**Sven Birkerts** (Bennington College). *Changing the Subject: Art and Attention in the Internet Age*. Graywolf Press, October 2015

**Sean B. Carroll** (University of Wisconsin-Madison). *The Serengeti Rules: The Quest to Discover How Life Works and Why It Matters*. Princeton University Press, March 2016

**Colin Dayan** (Vanderbilt University). *With Dogs at the Edge of Life*. Columbia University Press, December 2015

**Annie Dillard** (Key West, Florida). *The Abundance: Narrative Essays Old and New*. Ecco, March 2016

**Wendy Doniger** (University of Chicago). *Redeeming the Kamasutra*. Oxford University Press, March 2016

**Benjamin Fagan** (Auburn University; Academy Visiting Scholar, 2011–2012). *The Black Newspaper and the Chosen Nation*. University of Georgia Press, June 2016

**Susan Howe** (State University of New York at Buffalo). *The Quarry*. New Directions, November 2015

**Jerome Kagan** (Harvard University). *On Being Human: Why Mind Matters*. Yale University Press, March 2016

**F. M. Kamm** (Harvard Kennedy School). *The Trolley Problem Mysteries*, ed. Eric Rakowski (University of California, Berkeley). Oxford University Press, December 2015

**Sanford Levinson** (University of Texas at Austin). *An Argument Open to All: Reading "The Federalist" in the Twenty-First Century*. Yale University Press, November 2015

**Herbert Lindenberger** (Stanford University) and Frederick Aldama (Ohio State University). *Aesthetics of Discomfort: Conversations on Disquieting Art*. University of Michigan Press, February 2016

**Lewis Lockwood** (Harvard University). *Beethoven's Symphonies: An Artistic Vision*. W. W. Norton, October 2015

**Emiko Ohnuki-Tierney** (University of Wisconsin-Madison). *Flowers that Kill: Communicative Opacity in Political Spaces*. Stanford University Press, August 2015

**William J. Perry** (Stanford University). *My Journey at the Nuclear Brink*. Stanford University Press, December 2015

**Henry Petroski** (Duke University). *The Road Taken: The History and Future of America's Infrastructure*. Bloomsbury, February 2016

**Steven Pinker** (Harvard University). *Language, Cognition, and Human Nature*. Oxford University Press, October 2015

**Richard A. Posner** (U.S. Court of Appeals, Seventh Circuit). *Divergent Paths: The Academy and the Judiciary*. Harvard University Press, January 2016

**Lisa Randall** (Harvard University). *Dark Matter and the Dinosaurs: The Astounding Interconnectedness of the Universe*. Ecco, October 2015

**Robert B. Reich** (University of California, Berkeley). *Saving Capitalism: For the Many, Not the Few*. Knopf, October 2015

**George Rupp** (Columbia University). *Beyond Individualism: The Challenge of Inclusive Communities*. Columbia University Press, September 2015

**Harry N. Scheiber** (UC Berkeley School of Law) and Jane L. Scheiber (University of California, Berkeley). *Bayonets in Paradise: Martial Law in Hawai'i during World War II*. University of Hawai'i Press, February 2016

**Michael Schudson** (Columbia University). *The Rise of the Right to Know: Politics and the Culture of Transparency, 1945–1975*. Harvard University Press, September 2015

**Howard Schuman** (University of Michigan) and Amy Corning (University of Michigan). *Generations and Collective Memory*. University of Chicago Press, August 2015

**Ramamurti Shankar** (Yale University). *Fundamentals of Physics II: Electromagnetism, Optics, and Quantum Mechanics*. Yale University Press, June 2016

**Robert A. M. Stern** (Robert A. M. Stern Architects; Yale University) and Jimmy Stamp (Robert A. M. Stern Architects). *Pedagogy and Place: 100 Years of Architecture Education at Yale*. Yale University Press, April 2016

**Sherry Turkle** (Massachusetts Institute of Technology). *Reclaiming Conversation: The Power of Talk in a Digital Age*. Penguin Press, October 2015

**Robert Wuthnow** (Princeton University). *Inventing American Religion: Polls, Surveys and the Tenuous Quest for a Nation's Faith*. Oxford University Press, October 2015

**Philip Zimbardo** (Stanford University) and Nikita D. Coulombe (Hawai'i). *Man, Interrupted: Why Young Men are Struggling and What We Can Do About It*. Conari Press, April 2016

*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](mailto:bulletin@amacad.org). ■*



# Remembrance

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

**Arlin Marvin Adams** – December 29, 2015; elected in 1996

**Benedict R. O’Gorman Anderson** – December 13, 2015; elected in 1994

**Stephen W. Bosworth** – January 4, 2016; elected in 2010

**Pierre Boulez** – January 5, 2016; elected in 1968

**Malcolm H. Chisholm** – November 20, 2015; elected in 2004

**Robin Chandler Duke** – February 6, 2016; elected in 1992

**Joel Elkes** – October 30, 2015; elected in 1963

**Bernard G. Forget** – November 6, 2015; elected in 2007

**Alfred Goodman Gilman** – December 23, 2015; elected in 1988

**René Noel Girard** – November 4, 2015; elected in 1979

**Howard Green** – October 31, 2015; elected in 1972

**Judith Smith Kaye** – January 7, 2016; elected in 1999

**Ellsworth Kelly** – December 27, 2015; elected in 1996

**Helmut Heinrich Karl Ernst Koester** – January 1, 2016; elected in 1968

**A. Leo Levin** – November 23, 2015; elected in 1979

**Richard Levins** – January 19, 2016; elected in 1970

**Charles Duncan Michener** – November 1, 2015; elected in 1963

**Marvin Minsky** – January 24, 2016; elected in 1968

**Sidney Wilfred Mintz** – December 27, 2015; elected in 1990

**Douglass Cecil North** – November 23, 2015; elected in 1987

**Klaus Friedrich Roth** – November 10, 2015; elected in 1966

**Susanne Rudolph** – December 23, 2015; elected in 1998

**Herbert Eli Scarf** – November 15, 2015; elected in 1971

**Helmut Schmidt** – November 10, 2015; elected in 1996

**Joseph Harry Silverstein** – November 21, 2015; elected in 1965

**David Curtis Steinmetz** – November 26, 2015; elected in 2006

**Jui Hsin Wang** – January 17, 2016; elected in 1970

**Richard Alan Webb** – January 23, 2016; elected in 1998

**Carolyn D. Wright** – January 12, 2016; elected in 2005

*\*Notice received from October 30, 2015, to February 9, 2016*

## Ways of Giving to the American Academy of Arts & Sciences

The Academy depends on gifts and grants from members and other individuals, foundations, and corporations to support its work. Contributions may be made in a variety of ways.

### *Gifts of Cash and Securities*

The Academy benefits most directly from gifts of cash and securities, which may be unrestricted, directed toward specific initiatives, or designated for the endowment. Gifts of appreciated securities may provide special tax incentives to donors. Annual Fund gifts can now be made online; visit the Academy's website at [www.amacad.org](http://www.amacad.org).

### *Donor-Advised Funds*

Gifts through donor-advised funds (DAF) provide convenience and tax benefits to donors. DAF gifts, unrestricted and restricted, may be made directly from your sponsoring organization or online (visit the Academy's website at [www.amacad.org](http://www.amacad.org) to see if your sponsoring organization participates in online giving).

### *Bequests*

Bequests from Fellows and their spouses helped to create and build the Academy's endowment. Today, bequests continue this tradition and provide support for new initiatives, projects, and studies. Provision for including the Academy in an estate plan may be made in a new will, in a codicil to an existing will, or through trusts.

### *Other Planned Gifts and Naming Opportunities*

Please contact the Development Office for additional information about planned gifts and naming opportunities, including life-income gifts and gifts of appreciated property.

*For assistance in making a gift to the Academy please call Sonja Plesset, Chief Advancement Officer, at 617-576-5037.*

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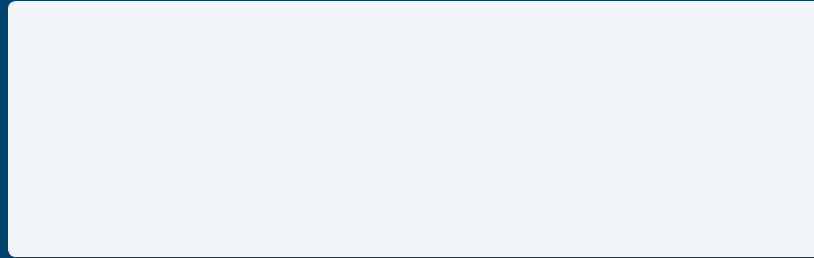
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