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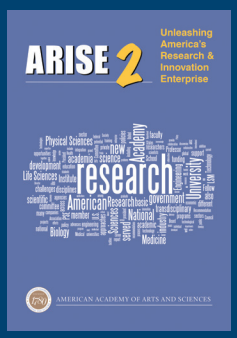
The Evolution of the Internet: Emerging Challenges and Opportunities

Tom Leighton, Tim Berners-Lee , and David D. Clark



ARISE II Report Calls for Reorganization of the U.S. Scientific Enterprise

Cyber-Archaeology and World Cultural Heritage: Insights from the Holy Land

Charles S. Stanish and Thomas Levy

ALSO:

Upcoming Events

JUNE

19th

Reception and Program on "The Heart of the Matter" – Washington, D.C.

Launching a national conversation on the importance of the Humanities and Social Sciences to America's future

OCTOBER

11th – 13th

Induction Weekend – Cambridge

11th – *Celebrating the Arts and the Humanities*
12th – *Induction Ceremony*
13th – *Symposium*

For updates and additions to the calendar, visit www.amacad.org/event.aspx.

Special Thanks to Donors

"This has been the second largest fund-raising year in the Academy's history, and we are grateful to all the Members and others who contributed," said Alan Dachs, member of the Academy Trust and Chair of the Development and Public Relations Committee. More than $9.1 million was raised in fiscal year 2013, which ended on March 31. The Annual Fund again exceeded its goal and surpassed $1.7 million for the first time. Gifts from all other sources – including grants for projects – totaled more than $7.4 million. The generosity of over 1,100 individuals; 27 foundations, corporations, and associations; and 58 University Affiliates made these results possible. Dachs thanked the members of the Development Committee for their efforts over the past year: Louise Bryson, James Cash, Richard Cavanagh, Jesse Choper, Jack Cogan, David Frohnmayer, Michael Gellert, Matthew Santirocco, Stephen Stamas, Samuel Thier, Nicholas Zervas, and Louis Cabot, Chair of the Board and Chair of the Trust.

"A growing number of leadership donors and institutional partners play a critical role in our ability to advance work that is informing policy- and decision-making in the United States and abroad. The Academy's projects, publications, and meetings around the country are providing independent, nonpartisan analysis of complex problems facing our nation. We rely on the support of Fellows and others to help us, and we thank all who do," said Cabot.

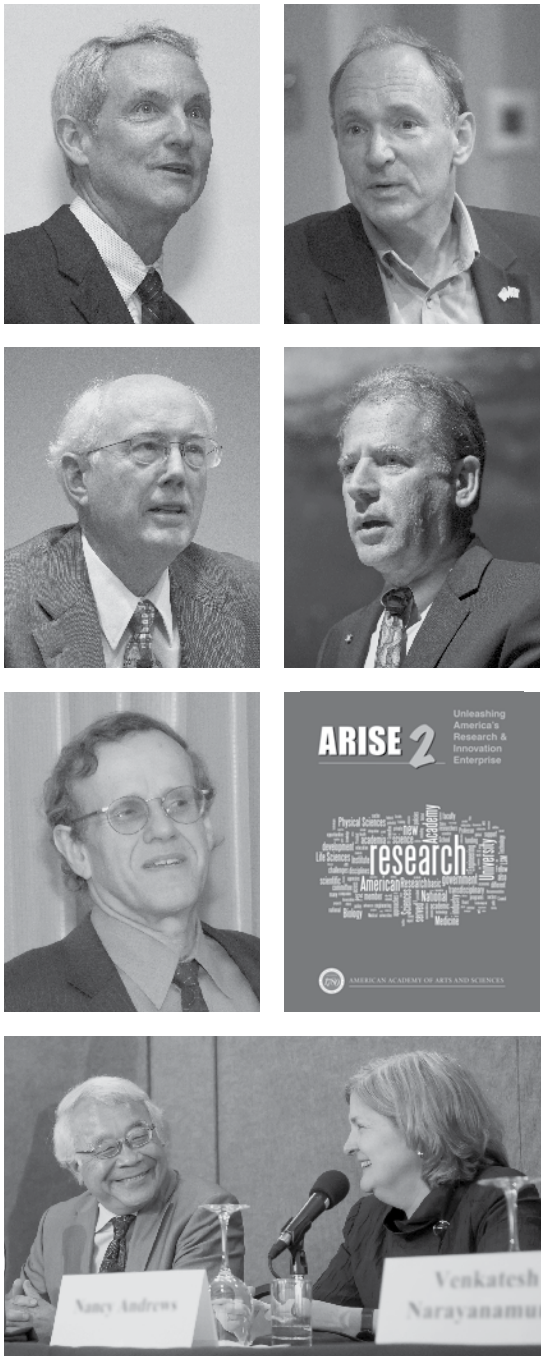
A complete list of contributors in 2012 – 2013 will be published in the 2013 *Annual Report*.

Contents

Projects and Activities

Presentations

Updates on Members



Clockwise from top left: Tom Leighton, Tim Berners-Lee, Thomas Levy, Cover of ARISE II, Nancy Andrews and Keith Yamamoto, Robert Rosner, and David D. Clark

New Report Calls for Reorganization of the U.S. Scientific Enterprise to Meet 21st Century Challenges

A new Academy report, *ARISE II: Unleashing America's Research & Innovation Enterprise,* offers recommendations for academia, government, and the private sector to help maintain America's leadership in science, technology, and medicine. *ARISE II* highlights the need for greater synergy between government, university, and industry research. It advocates for greater integration of theories, concepts, and applications from multiple scientific disciplines – biology, physics, medicine, engineering, and computer science – to solve the complex problems of the twenty-first century.

"Scientific and technological innovation has been vital to the economic prosperity and security of the United States," said Academy President **Leslie Berlowitz**. "Yet there is growing concern that the nation risks losing its position of global technological leadership. *ARISE II* examines the factors affecting America's productivity in science and technology and suggests steps to encourage transdisciplinary and transsector research collaborations."

The Academy released *ARISE II* on May 1, 2013, at the National Press Club in Washington, D.C., to an audience of government officials, journalists, and scientific leaders from universities, NGOs, and professional societies. Project cochairs **Venkatesh Narayanamurti** (Harvard University) and **Keith Yamamoto** (University of California, San Francisco) and committee member **Nancy Andrews** (Duke University School of Medicine) outlined the overarching goals and recommendations of the report.

Yamamoto observed that "progress illuminates new opportunities, but how we find them, much less take advantage of them, will depend on new modes of communication and cooperation across the sectors. There are opportunities for scientific research to address not only big scientific questions that are exciting in their own right, but also important societal issues that probably can't be solved in any other way: issues in health, environment, energy, food, and agriculture."

"Our objective is to break down barriers that still exist, to promote real sharing of tools and expertise, and to incentivize integrative approaches across traditional disciplines," said Andrews.

Narayanamurti remarked: "To connect research with the larger enterprise of discovery and innovation, we must involve industry. Because of the decline of research in the industrial laboratories in both the pharmaceutical and physical science sectors, it is important that much more such work be done in our universities and national laboratories – meaning that how industry funds science must change for the long term."

The ARISE II committee includes many of the nation's preeminent scientists and policy leaders from government, academia, and business.

Engaging Key Stakeholders

Project leaders recently met with **Cora Marrett**, Academy Fellow and Acting Director of the National Science Foundation (NSF), and NSF Assistant Directors **Fleming Crim** (Mathematical and Physical Sciences), **John Wingfield** (Biological Sciences), and **Pramod Khargonekar** (Engineering) to dis-

Keith Yamamoto (University of California, San Francisco) and **Nancy Andrews** (Duke University School of Medicine)

cuss the report's recommendations. In addition, the project leaders briefed senior policy staff from university and industry associations, including the Association of Public and Land-Grant Universities; the Association of American Universities; the American Association for the Advancement of Science; the Biotechnology Industry Association; the National Association of Manufacturers; and Battelle Memorial Institute, operator of several U.S. national laboratories.

Cora Marrett (National Science Foundation) and **Venkatesh Narayanamurti** (Harvard University)

The Academy released its first *ARISE* report, *Advancing Research In Science and Engineering: Investing in Early-Career Scientists and High-Risk, High-Reward Research*, in 2008. Chaired by **Thomas R. Cech**, Distinguished Professor at the University of Colorado Boulder and former President of the Howard Hughes Medical Institute, *ARISE I* addressed two critical issues: waning support for young investigators and the need to encourage potentially transformative research. The recommendations from *ARISE I* were incorporated into the American Recovery and Reinvestment Act of 2009 and subsequent federal budgets. The Department of Energy, the National Science Foundation, and the National Institutes of Health have all increased support for early-career researchers and potentially transformative research, as recommended in *ARISE I*.

The *ARISE II* report is available online at www.amacad.org/arise2.pdf.

The Academy is grateful to the S. D. Bechtel, Jr. Foundation, the Richard Lounsbery Foundation, the Research Corporation for Science Advancement, and the Gordon and Betty Moore Foundation for their support of the ARISE II project.

ARISE II Committee

Cochairs
Venkatesh Narayanamurti, Harvard University
Keith R. Yamamoto, University of California, San Francisco

Members
Nancy C. Andrews, Duke University School of Medicine
Dennis Ausiello, Harvard Medical School
Lawrence Bacow, Tufts University
Malcolm R. Beasley, Stanford University
Edward J. Benz, Jr., Dana-Farber Cancer Institute
David Botstein, Princeton University
H. Kim Bottomly, Wellesley College
Robert Brown, Boston University
Claude Canizares, Massachusetts Institute of Technology
Uma Chowdhry, DuPont
Mary Sue Coleman, University of Michigan
Alan Ezekowitz, Abide Therapeutics
Harvey V. Fineberg, Institute of Medicine
Mary L. Good, University of Arkansas
Leah Jamieson, Purdue University
Linda Katehi, University of California, Davis
Neal Lane, Rice University
Eugene H. Levy, Rice University
Joseph B. Martin, Harvard Medical School
Cherry A. Murray, Harvard School of Engineering and Applied Sciences
Gilbert Omenn, University of Michigan
Thomas D. Pollard, Yale University
Robert C. Richardson†, Cornell University
David D. Sabatini, New York University School of Medicine
Randy Schekman, University of California, Berkeley
Richard H. Scheller, Genentech, Inc.
Henri A. Termeer, Genzyme Corporation, ret.
Samuel Thier, Harvard Medical School
Leslie C. Berlowitz, *ex officio*, American Academy of Arts and Sciences

† *Deceased*

ARISE II Goals and Recommendations

The *ARISE II* report identifies two overarching goals and eleven recommendations that reach toward a new and powerful integration of the physical sciences and engineering (PSE) and the life sciences and medicine (LSM):

Goal 1: Move from interdisciplinary to transdisciplinary

Moving toward transdisciplinary research will require more than encouraging researchers from different disciplines to work together. A critical next step is to provide incentives and remove barriers so that the tools and expertise developed within discrete disciplines are shared and combined to enable a deep conceptual and functional integration across the disciplines.

- *Recommendation 1.1*
  Develop and foster a massive "knowledge network" that enables investigators from different disciplines to identify opportunities, establish collaborative efforts, and focus disparate expertise and approaches on problems of common interest.

- *Recommendation 1.2*
  Expand education paradigms to model transdisciplinary approaches: Develop new and support existing graduate and postdoctoral training programs that integrate concepts and technologies across PSE and LSM.

- *Recommendation 1.3*
  Expand support for shared core research facilities (especially those that span multiple PSE and LSM approaches), including funding for stable appointments of professional staff to direct them.

- *Recommendation 1.4*
  Ensure that appointments and promotion policies recognize, support, and reward contributions to collaborative and transdisciplinary research and education endeavors.

- *Recommendation 1.5*
  Better enable transdisciplinary research by scrutinizing current administrative policies, revising them to optimize efficiency and effectiveness, aligning incentives appropriately, and incorporating dynamic evaluation into future policies.

Goal 2: Promote cooperative, synergistic interactions among the academic, government, and private sectors throughout the discovery and development process

Creating an interdependent ecosystem requires incentives for basic and applied research, development, and deployment. Novel discoveries can emerge during the development process, and new technologies can arise out of basic research labs. The academic, government, and private sectors must develop an inclusive and adaptive environment that ensures that the unique objectives, skills, and points of view of the different sectors are integrated and optimally utilized.

- *Recommendation 2.1*
  Establish one or more "grand challenges" that will motivate alignment, cooperation, and integration of efforts and approaches across academia, industry, and government.

- *Recommendation 2.2*
  Develop and implement new models for research alliances between academia and industry.

- *Recommendation 2.3*
  Enhance permeability between industry and academia at all career stages.

- *Recommendation 2.4*
  Set new priorities for the technology transfer function between academia and industry with the explicit goal of maximizing exchanges of knowledge, resources, and people.

- *Recommendation 2.5*
  Develop policies that focus on common interests between academia and industry, while acknowledging and managing intrinsic and avoidable conflicts.

- *Recommendation 2.6*
  Create mechanisms that increase coordination and cooperation among government agencies that support PSE and LSM. ■

The ARISE II report is available online at http://www.amacad.org/arise2.pdf.

Financial Literacy and the Educated American

Every day, Americans make complicated financial decisions that will impact their future. Young adults must balance the rising expense of a college education with a projected increase in earning potential; prospective homeowners face a complex housing market in the aftermath of the mortgage crisis; and the decline in employer-managed pensions puts retirement choices directly in the hands of employees. But are our nation's citizens equipped to make decisions that are informed and fiscally responsible?

At a recent Academy symposium on "Financial Literacy and the Educated American," distinguished participants representing government agencies, academia, nonprofits, and the financial industry came together, united by a shared conviction that Americans need access to financial literacy education, as well as the support, tools, and consumer protections to safeguard their savings and investments. The day's lively discussion explored crucial questions of when and how this education in financial literacy should take place and what it should include.

The three-panel session was chaired by **Gerald Rosenfeld**, Advisor to the Chief Executive Officer and Vice Chairman of U.S. Investment Banking at Lazard, Ltd.; and Clinical Professor of Business at New York University Stern School of Business. The planning committee included **Leslie C. Berlowitz** (American Academy), **Annamaria Lusardi** (The George Washington University School of Business), **Alicia H. Munnell** (Boston College), **David B. Peterson** (Onera Media, Inc.; Tegris Advisors), and **Steven A. Sass** (Boston College). Rosenfeld called on participants to consider how the private sector, nonprofit organizations, and government agencies could best collaborate to advance "principles which have to be almost universally accepted as a common good."

The panel presentations focused on three broad topics:

- Financial Education over the Life Cycle;
- Financial Literacy Education, K-College; and
- Retirement.

Nearly 50 percent of Americans lack emergency savings or "rainy day" funds; a majority of people in the United States have not planned for retirement; and 60 percent of recent survey respondents say they have never been offered any financial literacy education. The symposium participants agreed that all stakeholders would need to work in partnership to resolve these issues. "We are all in this together," noted **Phyllis Borzi**, Assistant Secretary for the Employee Benefits Security Administration at the U.S. Department of Labor, who also emphasized the need to make personal financial advisors accountable. "If we really care about making sure that people are financially literate, education doesn't do it all and workplace programs don't do it all."

Eugene Dodaro, Comptroller General of the U.S. Government Accountability Office, discussed the potential for government agencies to capitalize on "teachable moments" that would improve citizens'

Symposium participant **Peter Tufano** (Saïd Business School, University of Oxford) with project advisor **Annamaria Lusardi** (The George Washington University School of Business)

Project chair **Gerald Rosenfeld** (Lazard Ltd.; New York University) with keynote speaker **John W. Rogers, Jr.** (Ariel Investments, LLC)

Financial Literacy, continued

money management skills. "I want to leverage the work we do across the federal government," he said, "and look for opportunities to strengthen financial literacy through interactions between the government and individuals."

Other participants argued the merits of starting financial education at a young age. Keynote speaker **John Rogers, Jr.**, Chairman, Chief Executive Officer, and Chief Investment Officer of Ariel Investments and founder of the innovative Ariel Community Academy, advocated strongly for embedding financial literacy programs into the core curriculum of public schools. "In this complicated financial world," he noted, "you really have to start kids early and have this education build over time, the way math and English and other important subjects do." He pointed out that financial literacy is about more than personal success. "Having financially literate citizens in our country helps engage our democracy and our political leaders in a very constructive way to tackle the tough issues we face."

"The language and tools of economics give our kids the ability to recognize and understand the nature of choice in their lives," observed panelist **Nan Morrison**, President and Chief Executive Officer of the Council for Economic Education. "It's a language that should not be foreign to our children, if equal opportunity in our country is a continuing aspiration."

As the symposium drew to a close, Academy President **Leslie Berlowitz** reminded participants that Abraham Lincoln once theorized that "how we teach children in one generation will be how well our Congress will perform in the next." She explained that the Academy is dedicated to promoting the competencies Americans need in a democratic society, and recommended that participants take a step back and put the issue of financial literacy "in the context of the other literacies or knowledge that we would like all young citizens to have."

The Academy is grateful to the Charles H. Revson Foundation and Academy Fellow Gerald Rosenfeld for their support of this work.

J. Michael Collins (University of Wisconsin, Madison), **Michael Staten** (University of Arizona; Take Charge America Institute), and **Geraldine Walsh** (Financial Industry Regulatory Authority; FINRA Investor Education Foundation)

Lewis Mandell (State University of New York at Buffalo), **Beth Kobliner** (author, *Get a Financial Life: Personal Finance in Your Twenties and Thirties*), and **Nan Morrison** (Council for Economic Education)

Financial Literacy and the Educated American Symposium Participants

Gerald Rosenfeld, *Project Chair; Advisor to the Chief Executive Officer and Vice Chairman, U.S. Investment Banking, Lazard Ltd.; Clinical Professor of Business, New York University Stern School of Business*

Leslie C. Berlowitz, *President, American Academy of Arts and Sciences*

Phyllis C. Borzi, *Assistant Secretary of Labor, Employee Benefits Security Administration*

J. Michael Collins, *Faculty Director, Center for Financial Security, University of Wisconsin, Madison*

Daniel Denecke, *Associate Vice President, Best Practices and Programs, Council of Graduate Schools*

Eugene L. Dodaro, *Comptroller General of the United States, U.S. Government Accountability Office*

Matt Fellowes, *Founder and Chief Executive Officer, HelloWallet*

Jason J. Fichtner, *Senior Research Fellow, Mercatus Center, George Mason University*

Leonard M. "Lenny" Glynn, *Director of Public Policy, Putnam Investments*

Michelle Greene, *Senior Vice President and Head of Corporate Responsibility, NYSE Euronext; Executive Director, NYSE Euronext Foundation*

Billy J. Hensley, *Director of Education, National Endowment for Financial Education*

Jeanne M. Hogarth, *Vice President of Policy, Center for Financial Services Innovation*

Jane P. Katz, *Officer and Director of Economic Education, Federal Reserve Bank of New York*

Beth Kobliner, *Author of Get a Financial Life: Personal Finance in Your Twenties and Thirties*

David Laibson, *Robert I. Goldman Professor of Economics, Harvard University*

Laura Levine, *President and Chief Executive Officer, Jump$tart Coalition for Personal Financial Literacy*

Annamaria Lusardi, *Denit Trust Distinguished Scholar and Professor of Economics and Accountancy, The George Washington University School of Business; Director, Financial Literacy Center*

Lewis Mandell, *Professor Emeritus and former Dean of the School of Management, State University of New York at Buffalo*

Rick Miller, *Founder, Sensible Financial Planning and Management, LLC*

Nan J. Morrison, *President and Chief Executive Officer, Council for Economic Education*

Alicia H. Munnell, *Peter F. Drucker Professor of Management Sciences, Carroll School of Management; Director, Center for Retirement Research, Boston College*

David B. Peterson, *Chief Executive Officer, Onera Media, Inc.; Senior Advisor, Tegris Advisors*

John W. Rogers, Jr., *Chairman, Chief Executive Officer, and Chief Investment Officer, Ariel Investments, LLC*

Mary C. Rosenkrans, *Director of Financial Education, Pennsylvania Department of Banking and Securities*

Julie Sandorf, *President, Charles H. Revson Foundation*

Steven A. Sass, *Associate Director, Financial Security Project, Center for Retirement Research, Boston College*

Jean C. Setzfand, *Vice President of Financial Security, AARP*

Michael Staten, *Take Charge America Endowed Chair, Norton School of Family and Consumer Sciences, University of Arizona; Director, Take Charge America Institute*

Peter Tufano, *Peter Moores Dean and Professor of Finance, Saïd Business School, University of Oxford*

Stephen P. Utkus, *Principal and Director, Vanguard Center for Retirement Research*

Dorothy Wallace, *Professor of Mathematics, Dartmouth College*

Geraldine M. Walsh, *Senior Vice President of Investor Education, Financial Industry Regulatory Authority; President, FINRA Investor Education Foundation* ■

Stewarding America: Civic Institutions and the Public Good

The Stewarding America project investigates the civic institutions that are critical for inspiring and modeling good citizenship. Through in-depth analyses of the government, the courts, the media, the military, corporations, unions, and the education system, the Academy is developing a better understanding of the role of these institutions in the American democratic system and considering ways to increase civic participation and public confidence in American leaders and institutions. "American Democracy & the Common Good," the Spring 2013 issue of *Dædalus*, is a part of this project.

The Academy is grateful to the S. D. Bechtel, Jr. Foundation for supporting this work.

Dædalus Examines "American Democracy & the Common Good"

In the face of increasing polarization and considerable stress on the American polity, this issue of *Dædalus* begins a much-needed public conversation about how individuals and institutions can work together to strengthen democracy and promote the common good.

"Fundamental American institutions of democracy are held in public trust. They provide a continuity of law and procedure, of practice and participation, and of knowledge and inquiry from one generation to the next," said Academy President **Leslie C. Berlowitz**. "When they serve the short-term interests of particular individuals or groups, they erode public trust; they erode the faith of citizens in the very legitimacy of our constitutional democracy."

The issue is guest edited by Academy Fellows **Norman J. Ornstein** (Resident Scholar at the American Enterprise Institute) and **William A. Galston** (Senior Fellow at the Brookings Institution); the volume analyzes particular sections of our social fabric while also providing a strong overview of the entire tapestry.

"Our civic life may be fraying at the edges, the essayists suggest, but it is possible to reverse the damage and restore our sense of common purpose," writes Ornstein in his introduction. "Indeed, it is necessary and urgent that we get to the work of doing so."

The authors in this issue pose compelling questions for our public institutions:

- In "Reluctant Stewards: Journalism in a Democratic Society," **Michael Schudson** (Columbia University) writes: "Could the media do better in serving democratic ends? A better journalism might be possible if journalists had a more sophisticated sense of what it means to serve democratic ends. It is more than providing citizens with the information they need to make sound decisions in the voting booth."

- In "The American Corporation," **Ralph Gomory** (New York University Stern School of Business) and **Richard Sylla** (New York University Stern School of Business) question why corporations that are focused on maximizing shareholder profit rather than a larger public good get government bailouts and the right to spend corporate funds in electoral politics: "The great American corporations today are doing well for their top managers and shareholders, but this does not mean that they are doing well for the country as a whole."

- In "The Challenges Facing Civic Education in the 21st Century," **Kathleen Hall Jamieson** (University of Pennsylvania) examines ways in which polarized politics and shifting priorities in school reform have undermined civics education across America. "Despite the fact that civic education produces an array of positive outcomes, the citizenry's current level of civic knowledge is far from ideal, and the role of civic education in schools is far from secure," she writes.

- In "What is the Common Good?" former congressman **Mickey Edwards** (Aspen Institute) addresses the struggle to agree on a single definition of the common good. "The problem is that where emotion overrules process, the sides themselves become confused, and conservatives and liberals alike

sometimes champion the right of the collective to deny an individual a right to which he or she might otherwise be entitled. There is a confusing lack of consistency in determining where the common good lies."

- **Thomas E. Mann** (Brookings Institution) and **Norman J. Ornstein** (American Enterprise Institute), in "Finding the Common Good in an Era of Dysfunctional Governance," raise alarms about government failures and partisan rancor that are "dangerous to the fundamental legitimacy of decisions made by policy-makers." They consider a variety of cultural and structural changes that may be required to fix the problem.

All essays in the volume are available for a limited time online at http://www.amacad.org/stewardingamerica. Print and Kindle copies of the new issue can be ordered at: http://www.mitpressjournals.org/loi/daed. ■

A Call for Ideas

The Academy is examining the institutions that steward American democracy. ***We call on Academy members to help us think about ways that we can foster greater cooperation and ideals of good citizenship.*** How can our work contribute to greater public confidence in American institutions? Please submit your ideas to stewardingamerica@amacad.org; select responses may be featured on the Stewarding America project page on the Academy's website.

Spring 2013 *Dædalus* "American Democracy & the Common Good"

Leslie C. Berlowitz (American Academy): *Foreword*

Norman J. Ornstein (American Enterprise Institute): *Introduction*

William A. Galston (Brookings Institution): *The Common Good: Theoretical Content, Practical Utility*

Thomas E. Mann (Brookings Institution) & **Norman J. Ornstein** (American Enterprise Institute): *Finding the Common Good in an Era of Dysfunctional Governance*

Jeffrey Rosen (George Washington University Law School): *Can the Judicial Branch be a Steward in a Polarized Democracy?*

Geoffrey R. Stone (University of Chicago Law School): *The Supreme Court in the 21st Century*

Andrew A. Hill (U.S. Army War College), **Leonard Wong** (U.S. Army War College) & **Stephen J. Gerras** (U.S. Army War College): *The Origins & Lessons of Public Confidence in the Military*

Kathleen Hall Jamieson (Annenberg School for Communication, University of Pennsylvania): *The Challenges Facing Civic Education in the 21st Century*

Mickey Edwards (Aspen Institute): *The Case for Transcending Partisanship*

Jim Leach (formerly, National Endowment for the Humanities): *Citizens United: Robbing America of Its Democratic Idealism*

Ralph Gomory (New York University Stern School of Business) & **Richard Sylla** (New York University Stern School of Business): *The American Corporation*

Andy Stern (Richman Center for Business, Law, and Public Policy, Columbia University): *Unions & Civic Engagement: How the Assault on Labor Endangers Civil Society*

Peter Dobkin Hall (City University of New York; Hauser Center for Nonprofit Organizations, Harvard University): *Philanthropy & the Nonprofit Sector*

Michael Schudson (Columbia University): *Reluctant Stewards: Journalism in a Democratic Society*

Deborah Tannen (Georgetown University): *The Argument Culture*

Amy Gutmann (University of Pennsylvania) & **Dennis Thompson** (Harvard University): *Compromise & the Common Good*

Howard Gardner (Harvard Graduate School of Education): *Reestablishing the Commons for the Common Good*

Kwame Anthony Appiah (Princeton University): *The Democratic Spirit*

Washington, D.C.

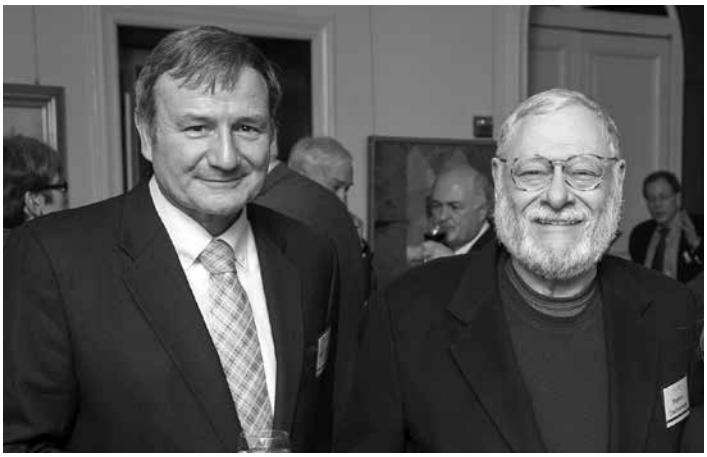
March 18, 2013

Leslie C. Berlowitz (President of the Academy) welcomed Fellows and guests to a reception at the Cosmos Club in Washington, D.C. **Steven Knapp** (President of The George Washington University), **Richard A. Meserve** (President of the Carnegie Institution for Science), **Norman Ornstein** (Resident Scholar at the American Enterprise Institute for Public Policy Research), **William A. Galston** (Senior Fellow and the Ezra K. Zilkha Chair in Governance Studies at the Brookings Institution), and **Robert W. Fri** (Visiting Scholar and Senior Fellow Emeritus at Resources for the Future) spoke about Academy projects in the humanities, arts, and education; global security and energy; and American institutions and the public good.

Robert Gagosian (Consortium for Ocean Leadership) and **Cora Marrett** (National Science Foundation)

C. Dan Mote, Jr. (National Academy of Engineering; University of Maryland) and **Charles Holliday, Jr.** (Bank of America)

Andrew Feinberg (Johns Hopkins University School of Medicine) and **Donald McHenry** (Georgetown University)



Karl Eikenberry (Stanford University) and **Stephen Trachtenberg** (The George Washington University)

John Bryson (Woodrow Wilson International Center for Scholars) and **G. Wayne Clough** (Smithsonian Institution)

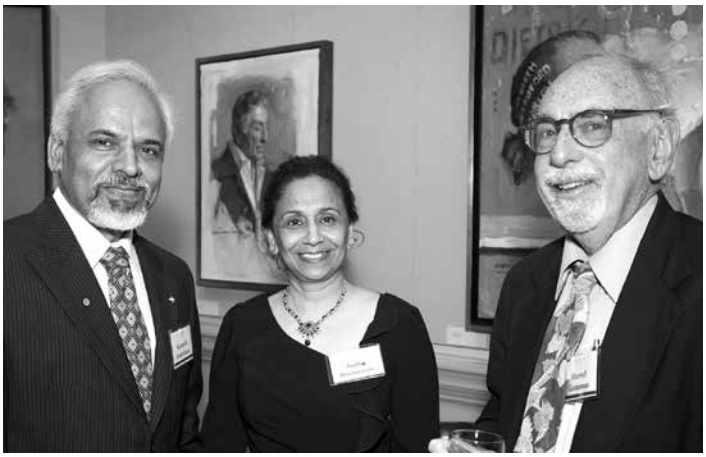
Norman Ornstein (American Enterprise Institute) and **Marvin Kalb** (United States Institute of Peace)

Norman Neureiter (American Association for the Advancement of Science), **Richard Meserve** (Carnegie Institution for Science), and **Robert Fri** (Resources for the Future)

New York City

May 9, 2013

More than 100 Academy members and guests attended a reception in New York City in honor of New York Area Fellows. **Louis W. Cabot** (Chair of the Board and Chair of the Trust of the Academy), **Leslie C. Berlowitz** (President of the Academy), **Annette Gordon-Reed** (Carol K. Pforzheimer Professor, Radcliffe Institute for Advanced Study; Charles Warren Professor of American Legal History, Harvard Law School; Professor of History, Harvard University), and **Richard Sylla** (Henry Kaufman Professor of the History of Financial Institutions and Markets, Professor of Economics, New York University Stern School of Business) spoke about the unique role that the Academy plays in addressing complex challenges to our global society.



Katepalli Sreenivasan (Polytechnic Institute of New York University), **Sudha Sreenivasan** (New York, New York), and **Maxwell Gottesman** (Columbia University Medical Center)

Louis W. Cabot (Cabot-Wellington, LLC) and **Carol Gluck** (Columbia University)

Annette Gordon-Reed (Harvard University), **Frederick Schauer** (University of Virginia School of Law), and **Robert Keohane** (Princeton University)

Martin Leibowitz (Morgan Stanley) and **Richard Sylla** (New York University Stern School of Business)

Edward Rothstein (New York Times Company), **Leslie C. Berlowitz** (American Academy), and **Albert Maysles** (New York, New York)

Mark Kaplan (Skadden, Arps, Slate, Meagher & Flom LLP & Affiliates), **Michael Gellert** (Windcrest Partners), and **Alfred Spector** (Google, Inc.)

Wayne Proudfoot (Columbia University), **Judith Shapiro** (Barnard College; Teagle Foundation), and **George Rupp** (International Rescue Committee)

Jerald Milanich (University of Florida; Florida Museum of Natural History), **John Wilford** (*New York Times*), and **Maxine Margolis** (University of Florida; Columbia University)

David W. McLaughlin (New York University), **Barry Coller** (Rockefeller University), and **Martin Blaser** (New York University School of Medicine)

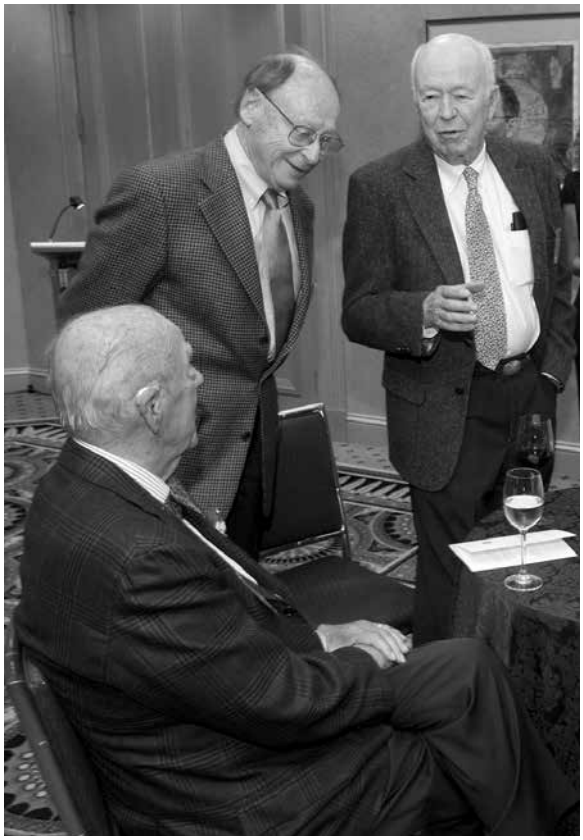
San Francisco, California

May 21, 2013

Academy Trust member **Alan M. Dachs** (President and Chief Executive Officer of Fremont Group) and **Laurie Dachs** (President of the S. D. Bechtel, Jr. Foundation) welcomed Fellows and guests to a reception in San Francisco in honor of newly elected Bay Area Fellows. **Leslie C. Berlowitz** (President of the Academy), **Robert J. Birgeneau** (Chancellor Emeritus of the University of California, Berkeley), **Jesse H. Choper** (Earl Warren Professor of Public Law at UC Berkeley School of Law), and **Keith R. Yamamoto** (Vice Chancellor for Research and Executive Vice Dean of the School of Medicine at the University of California, San Francisco) spoke about the Academy's role as an independent policy research center, convening leaders from the academic, business, and government sectors to address critical challenges facing our global society.

Arun Majumdar (Google.org) and **Peter Norvig** (Google, Inc.)

Gordon Bell (Microsoft Corporation) and **Deepak Srivastava** (Gladstone Institute of Cardiovascular Disease; University of California, San Francisco)



George Shultz (Stanford University), **Bernard Osher** (Bernard Osher Foundation), and **Stephen D. Bechtel, Jr.** (Bechtel Group, Inc.; Fremont Group)

Sharon Levy (San Francisco, CA), **Jay Levy** (University of California, San Francisco), and **Keith Yamamoto** (University of California, San Francisco)

Alan Dachs (Fremont Group) and **Laurie Dachs** (S. D. Bechtel, Jr. Foundation)

T. Don Tilley (University of California, Berkeley) and **Claude Fischer** (University of California, Berkeley)

Regis Kelly (QB3, California Institute for Science and Innovation; University of California, San Francisco) and **Richard Rosenberg** (Bank of America, San Francisco)

Restoring Justice: The Speeches of Edward H. Levi

edited by Jack Fuller, with a Foreword by Larry D. Kramer

Reflections by Jack Fuller

Jack Fuller, a Fellow of the American Academy, served as Editor and Publisher of the Chicago Tribune. He was awarded the Pulitzer Prize for journalism. He served as special assistant to Edward H. Levi in the Department of Justice.

When Edward Levi took the oath of office in Washington, D.C, in February of 1975, he became the fifth Attorney General in six years. Two of his four predecessors ended up convicted of crimes related to the Watergate scandal. The former acting head of the Federal Bureau of Investigation resigned after admitting he had destroyed documents on the orders of the White House Counsel. Special committees were gearing up on Capitol Hill to investigate three decades of secret history – including the FBI's. Confidence in the integrity of federal justice was at a nadir. This bore down heavily on the thousands of Justice Department officials who had served well and faithfully throughout the crisis.

When Levi left office a little less than two years later, the most sensitive intelligence operations of the FBI were governed by new guidelines that required regular review by the Attorney General's office and, in some cases, authorization by the Attorney General himself. Because of these guidelines, the number of domestic intelligence cases (of the sort the FBI had run against leftist groups, civil rights organizations, and anti-war protestors) had declined from about 5,000 to fewer than 300. A bill was working its way through Congress to establish a special court authorized to issue warrants for electronic surveillance in foreign intelligence cases, supplanting the process of Attorney General authorization, based on a delegation of presidential power. The legal basis for the activities of the intelligence agencies had been clarified, which was a constraint but also a protection.

Most important, inside and outside his department Levi helped restore the belief that the Department of Justice was committed to the rule of law. After he returned to the University of Chicago as an emeritus professor, and later became president of the American Academy, Levi came to be known as the very model of a modern attorney general.

Levi's speeches and testimony in Congress played a vital role in reversing the crisis of legitimacy brought on by Watergate. He believed in government by discussion, and he led by example. He believed in recognizing the complexity of issues in which important national values (security and individual liberty, for example) pushed in contrary directions. He believed in speaking as openly as possible about the most sensitive and politically divisive matters. And he believed in the kind of intellectual honesty that states the reasons against one's position as forcefully as one would want one's own to be stated.

***Portrait of Edward H. Levi* by Everett Raymond Kinstler**

Levi's service as Attorney General coincided with the bicentennial, and he used the occasion to remind the public that the issues of his day were not entirely new. He spoke of the tensions inherent in the Constitution itself, the way the Founders dealt with them, and the origins of the nation's fundamental values and law. He went back even beyond the American Revolution to recall the development of the idea of the rule of law in British history. Levi often spoke with eloquence, sometimes with humor, and always with seriousness of purpose.

These speeches remind us what it sounds like when a government leader forgoes the spin, speaks to us as adults, trusts us with difficult facts, and transcends party and ideology in pursuit of wise governance. As Larry Kramer, president of the Hewlett Foundation, former dean of the Stanford Law School, and member of the American Academy, wrote in his foreword, "Reading the speeches in this volume really made me miss Edward Levi." ■

Restoring Justice: The Speeches of Edward H. Levi, edited by Jack Fuller, with a Foreword by Larry D. Kramer, University of Chicago Press, 2013, is available from the University of Chicago Press at http://press.uchicago.edu/ucp/books/book/chicago/R/bo15507513.html.

The Evolution of the Internet: Emerging Challenges and Opportunities

On June 6, 2012, Internet pioneers **Tom Leighton**, Chief Scientist at Akamai Technologies and Professor of Applied Mathematics at MIT, **Sir Tim Berners-Lee**, Director of the World Wide Web Consortium and 3COM Founders Professor of Engineering at MIT, and **David D. Clark**, Senior Research Scientist at the MIT Computer Science and Artificial Intelligence Laboratory, discussed the future of the Web. The meeting, presented in collaboration with the Royal Society and the British Consulate-General, was the inaugural program in a lecture series on 'GREAT Science,' organized by the U.K. government's Science and Innovation Network to profile international science excellence. The following is an edited transcript of the presentations.

"Today we have Google, Facebook, Hotmail, Wikipedia, and even Wikileaks, and thousands of other websites and services that help us share information and that define our everyday lives."

– Tom Leighton, Cofounder and Chief Executive Officer of Akamai Technologies; Professor of Applied Mathematics at the Massachusetts Institute of Technology

Tom Leighton

Tom Leighton is Cofounder and Chief Executive Officer of Akamai Technologies and Professor of Applied Mathematics at the Massachusetts Institute of Technology. He was elected a Fellow of the American Academy of Arts and Sciences in 2003.

Both Sir Tim Berners-Lee and David Clark have had, and continue to have, an enormous influence on the Internet and how we experience it in our daily lives.

It is a real pleasure to be part of tonight's collaboration between the American Academy, the British Consulate, and the Royal Society. It would be very hard, I think, to find two more qualified individuals to speak about the future evolution of the Internet than my colleagues Sir Tim Berners-Lee and David Clark. Both Tim and David have had, and continue to have, an enormous influence on the Internet and how we experience it in our daily lives.

In 1989, when Tim wrote his memo outlining his ideas for creating a set of protocols to help scientists at multiple locations around the globe share information more easily, protocols that would later become the foundation for the World Wide Web, his boss at CERN in Switzerland wrote in the top corner, "Vague, but exciting."

Who knew then that it would take over the world and transform it? By inventing the Web and insisting on making the tools freely available to all, Tim fundamentally reframed the way we use and share information. Today we have Google, Facebook, Hotmail, Wikipedia, and even Wikileaks, and thousands of other websites and services that help us share information and that define our everyday lives.

Tim has continued to help guide the development of the Web as Director of the World Wide Web Consortium, which he founded in 1994. The consortium serves as a consensus-driven neutral forum for companies and organizations to agree on new common computer protocols.

Twenty years after conceiving a radically improved means of sharing documents, Tim is today focused on another large challenge: getting governments, organizations, and individuals to share large and ever-growing volumes of data. Making vast amounts of raw data freely available on the Web could have fundamental implications for government transparency, as well as for how scientific research is advanced in such areas as drug discovery, climate research, Web analytics, and many other fields.

Last month, the British government announced the creation of the Open Data Institute, which Tim will lead. This initiative will bring together business, the public sector, academic institutions, and developers to focus on novel approaches to harness open data.

MIT also is partnering with a number of organizations to develop multidisciplinary approaches to address the Big Data challenge.

David Clark's research has long focused on improving and evolving the architectural underpinnings of the Internet, making it work. As chief protocol architect during the development of the Internet in the 1980s, David helped shape the Internet as we know it today.

More recently, David has focused on reimagining the infrastructure that connects computer users around the world. He is thinking about ways to enhance and enrich users' experiences while also protecting them from some of the more nefarious ways that unscrupulous people seek to use the new technology.

Addressing such questions requires two kinds of responses: technical engineering solutions and social, or behavioral, components. The questions become even more complex when one considers that most of the investment that is shaping the Internet today comes not from government but from private-sector entities. David will offer his thoughts on the question, "What should we expect of a global Internet?"

Sir Tim Berners-Lee

Sir Tim Berners-Lee is Director of the World Wide Web Consortium and the 3COM Founders Professor of Engineering at the Massachusetts Institute of Technology. He is a Fellow of the Royal Society and was elected a Fellow of the American Academy of Arts and Sciences in 2001.

I would like to talk about technology and science, and then about policy, in particular keeping the Internet open. I have been fighting for that openness for a long time. I also want to talk briefly about how we can use the Net and the Web to really change the world.

When you introduce a change, there is a technical side and there is a social side, and the Web is as much a social creation as it is a technical creation. The Web works because when you click on a link two computers talk to each other and magically a copy of a document is delivered to your computer. But this does not work unless people make links.

Why do people make links? They make links because they want people to appreciate the document they have created. And they want this for lots of reasons. Maybe every time somebody reads the document, the creator gets some money from advertising. Whatever their reasons for wanting people to appreciate the document, they try to make them of higher value by making links to other really cool things. To do that, the person making the links must try to second-guess the person following the links to figure out which links they will want to follow.

Although you can look at the Web as a technical system, perhaps a more reasonable or useful way is to look at it as a system for connecting humanity through technology.

So although you can look at the Web as a technical system, perhaps a more reasonable or useful way is to look at it as a system for connecting humanity through technology.

Traditionally, I have spent my time involved with the Web layer, which is different from the Internet layer. The Internet layer, which transports packets between different computers, was designed as a platform. One of the things that could be built on it was the Web. The Web is yet another platform that allows people to build more things.

The idea of having layers in the architecture has been very important because it has allowed people to work on different layers independently, without the whole thing having to be coordinated. So, I could invent the Web and write a new protocol, "http," the hypertext transfer protocol, and I could implement it. I could set it running on a computer, get it talking to another computer, without asking any of the people who ran the Internet.

Back in the days when you had dial-up modems, you would dial up, put the telephone down in its cradle, and connect at 300 bits a second. You could imagine the modem's crackle to be the bits going by. Later on you might connect at 1200 bits a second. Today we are at 300 million or 300 billion bits per second. But the way the Web works on top of the Internet is still the same. Web browsers will work at a link speed of 300 bits per second, or 300 million, or 300 billion.

That points to really good design of the Internet at the layer system. It has allowed webpages to get more and more sophisticated. The specification for the markup language HTML, which I originally wrote down on a piece of paper, is now a thick document and has become HTML5. This latest version is very exciting, but basically it is a continuation of the development of HTML.

The real revolution with HTML5 is that every webpage can now be its own computing platform. A webpage can now run a program, and when webpages can run programs, then suddenly the world is a lot of webpages talking to each other and to servers. From the point of view of art, culture, and business, as well as computer science, all kinds of interesting things can happen.

If you can make the Web work on mobile devices, then you can get it to people who do not have Internet connections by wire. A lot of people now use the Web on mobile devices, and not just executives. In developing countries, a remote village might not have wired Internet, but they might have mobile. Maybe one person in the village will save up and spend a ridiculous portion of their annual income on a smart phone. Suddenly the whole village has access to information, the ability to communicate and put itself on the map.

What I do not want to see is the people who actually run the Internet filter it for commercial reasons. And plenty of governments already filter the Internet. They block sites for political reasons, for stability reasons.

A few of us have noticed that the Web is getting quite big. One estimate I saw put the number of webpages at about ten to the power of eleven. That is more webpages than there are neurons in the brain. (Of course, while webpages are constantly being added to the Web, your brain is alas constantly losing neurons!)

The Web is a very complex thing. We all depend on it, and we assume that it is going to work. When we get up in the morning we expect we will be able to find the weather, and we will be able to buy things, and the market will be relatively stable. That is, if we saw something on eBay yesterday, we know we can go online and buy it tomorrow. We assume that when we look on Twitter we will, most of the time, see things that are useful, that help us get a realistic idea of what is going on.

But nobody had done the math to show that that would always be the case. Nobody had done the math to show that tomorrow Twitter will still be broadcasting truth rather than fiction. Nobody had shown that it would not become socially unstable, that it would not, in fact, become more of some form of a massive conspiracy theory. And meanwhile, the people who are connected through Twitter are also people who make decisions as to how to invest money as part of the world's economic system. And when people invest as a function of what they see on the Internet, suddenly the economic system is now a very complex system of people connected by Twitter. (Can you imagine somebody investing because of what they saw on Twitter? Well, nowadays if you do not take Twitter into account when you invest, you are probably making a mistake.) But what happens to the whole system when people start taking Twitter into account when they invest?

Questions like this led some colleagues and me to suggest that people should study Web Science, and now there are Web Science labs around the world, with Web scientists, conferences, and journals. Web Science is like cognitive science for the brain. It is very multidisciplinary, and because it brings together people from all disciplines, I encourage all of you, whatever your discipline, to spend some time thinking about how your discipline relates to the study of the Web.

All the fun things that happen on the Web, all the protocols people have designed to run over the Internet, all those depend on the Internet actually working. By that I do not just mean that I can get to some website. For me, it is really important that I can get to any one. It is really important that if I am trying to figure out, say, who I am going to vote for, that I should be able to get to any party's website.

I also do not want to click on a link for, say, an independent Moldovan film (perhaps I am a Moldovan expatriate) and find that I can't watch the film because I get my Internet from my cable company and it has the old-fashioned belief that it should be telling me which movies to watch tonight. "Have you seen the selection of twenty movies we've got for you tonight? It's really exciting." "No, I want to watch this Moldovan one." "Oh, well, sorry, but that website has not partnered with us."

What I do not want to see is the people who actually run the Internet filter it for commercial reasons. I don't want to see governments doing that either. And plenty of governments already filter the Internet. They block sites for political reasons, for stability reasons. And it is not just the governments you are probably thinking of.

For example, the United States will block the website of a foreign company that it believes has been selling, for example, fake Ralph Lauren products, because they violate the trademark of an American company. This will happen without the accused company ever being taken to court. Sites just get taken down by the U.S. government. Yet we were shocked when the old regime in Egypt disconnected Egypt from the rest of the world. But a lot of people, when they saw that happen, started to realize we should think about who can disconnect us.

Lots of countries are putting through rules that will allow the government – different parts of the government for different reasons – to disconnect arbitrary people from the Internet. In France, they have it in for families whose children steal music. If a child is accused three times of stealing music, the entire family can be isolated, removed from the Internet.

We are realizing that access to the Internet is not just a luxury. The gap between those who are connected and those who are not is so large that if you disconnect someone's house it is a little bit like imprisoning them. The arguments about access to the Internet start to sound like the arguments we have about human rights.

The UN's Universal Declaration of Human Rights mentions being able to access and impart information, but it doesn't really encompass all the things you can do on the Internet. So, a lot of discussion is taking place about whether we need

to translate the declaration into something which actually explains what that means in the age of the Internet.

At the simplest level, it means nobody should be spying on what I do, and nobody – not large governments, not large corporations – should be filtering who I can connect to. The fundamental point is that the Internet – the ability to be part of the information society – now has to be considered as a human right.

So, when we have access to it, how should we use it? Well, we should put data on it, including government data, as the Open Data Institute in the United Kingdom is doing. Scientific data is also very important. When you publish a paper, what should you do with the data you used in that document? You should make it available so that others can reproduce your results.

When data is referenced by journals, access to the data behind the articles should be free, because the data have more value and are more exciting when you can connect them to other data. Some of the large challenges in science might not be solved until we can get a lot of data linked together on the Web.

How else should we be using the Web? The first year this thing was popularly visible, and people started using it, everybody exulted over the fact that the Web breaks down barriers: it allows you to look at a website of somebody in another country, a site that might be in a completely different language. With the Web you can go anywhere in the world, free yourself of the constraints of this town, this city, this state, this country.

But I ask you to think about whether you have actually done those things today. When you put a group of kids in front of an Internet-connected game machine on which they can not only play a video game, which is very exciting, but can play with other people on the network and with other people anywhere in the world, chances are they will actually play with the boy next door. Kids will play with their existing friends on the Internet, but they won't actually be discovering and making friends with people in other countries.

Social networking sites will typically suggest connections. If a person wants to connect with you, the site might suggest that while you are connecting with them, why don't you also connect with this other person, because you have a lot of friends in common.

What is wrong with this picture? If you find all the friends of friends and make them into your first-class friends, all one thousand of them, then your social graph, the interconnections that bind you together, will be a very tightly knotted lump. Going to a party will be great because all the people you will meet there will be people you already know. It will also be a terrible party, because you won't meet anybody new.

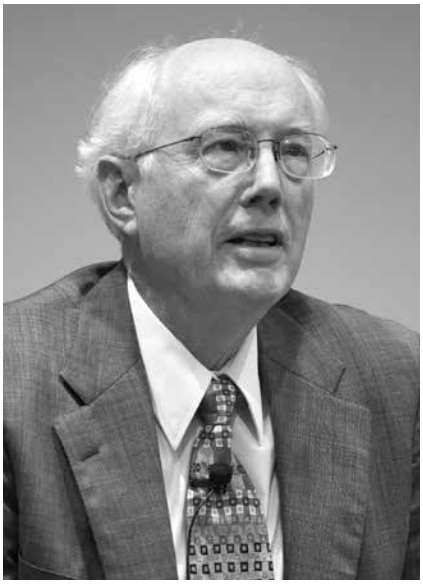
We are realizing that access to the Internet is not just a luxury. The gap between those who are connected and those who are not is so large that if you disconnect someone's house it is a little bit like imprisoning them.

We should start to think about what I call "stretch friends." When as a child you apply to college, you pick several safety schools and maybe one or two that are more of a stretch. The stretch colleges are going to be hard to get into, but if you do really well, then maybe you will make it. A stretch friend is the friend that every now and again you pick, or the system suggests to you, saying, "You know, you are friends with so many people in this Academy, this town, this field, this gender, this religion, and I can suggest a lot more of them, but just today I want to introduce you to somebody who is similar on many axes, but he is in Iran." Or "But he is Catholic." Or "But she is a woman."

The idea is to make an extra effort to connect with somebody who is on the other side of a boundary because I think we need more of this. If you look at sizes of all the groups that are on the Internet and at sizes of interactions, you should ideally, I hypothesize, find a power law, perhaps a Zipf distribution. There should be some very large groups and some smaller ones, with people dividing their time between various different communities, of different scales.

Out of all the groups of various sizes, you should then get a lot of emphasis on the national group, and then less emphasis, say, on the American Academy, and maybe just a little emphasis on, if there were such a thing, a Massachusetts Academy, or an Academy in a foreign country you have never been to. We need to take some of the emphasis on the national and move it. We need to stretch.

This is the master plan: Everybody makes one stretch friend a week and bit by bit, in the pubs and in the bars, people discuss what their stretch friends think and how and why they have such strange ideas. And bit by bit we start to understand where the other people are coming from. And bit by bit we stop feeling we ought to invade them. Bit by bit we move toward a world that is generally more peaceful.



David D. Clark

David D. Clark is Senior Research Scientist at the Computer Science and Artificial Intelligence Laboratory at the Massachusetts Institute of Technology. He was elected a Fellow of the American Academy of Arts and Sciences in 2002.

For normal users, the Internet experience today is defined by applications, not by the fact that it carries packets. . . . Most people today equate the Internet with Facebook and Twitter, *World of Warcraft*, virtual worlds like Second Life, or Google, or Yelp, where you can go to rate almost anything.

Tim and I did not coordinate, but it turns out his talk is a great introduction, because I want to talk about some pragmatic issues having to do with the openness of the Internet, especially in the global context. But since he pointed out that many of our friends are local, I have to tell you my own personal story of U.S.-U.K. relations. My son, who is an avid *World of Warcraft* player, found a very interesting player that he greatly enjoyed, and after a while he figured out that the player was a woman, and he ended up marrying her. She's from England. So, not all our friends are next door. In fact, if you sort the world according to your prowess in *World of Warcraft*, you may discover that the person you are talking to is not the kid next door but a woman from Oxford, England.

I started out in the 1970s as a purely technical engineer. I designed protocols. I wrote TCP – that is part of the Internet software – for the IBM PC. Sometime in the 1990s I had a revelation, which was that technologists were not in charge. I realized the people who invested were in charge, and I responded to this by hiring an economist, which caused my colleagues to think I had taken leave of my senses.

When we first built the Internet, it was a technical system and was defined by technical standards. And that is really all that constrained it; it did what standards do, which is to work the same everywhere. The first applications, such as email, were by and large used by a fairly homogenous population, and they worked the same everywhere.

So this wonderful little vision emerged that perhaps the Internet was a homogenous global platform for human interaction. This led to some naive and overly optimistic fantasies about the future of the Internet. One of the spokesmen for the early vision of the global Internet was a man named John Perry Barlow, who wrote, "Governments of the Industrial World, you weary giants of flesh and steel, I come from Cyberspace, the new home of Mind. On behalf of the future, I ask you of the past to leave us alone. You are not welcome among us. You have no sovereignty where we gather."

Heady stuff. John is an interesting character. He is a cattle rancher from Wyoming, founder of the Electronic Frontier Foundation, and a lyricist for The Grateful Dead, which is an interesting mix of professions.

Now, whatever he or anyone else thought back then, this is not the Internet we have today. Sovereignty is asserting itself, and along with it comes laws and policemen and criminal prosecution. We have regulation, and at the international level we have a lot of disagreement about what the Internet should be. Even Barlow now says of his earlier statement, "We all get older and wiser."

So, what do we have today? For normal users, the Internet experience today is defined by applications, not by the fact that it carries packets (only geeks send packets for the fun of it . . . which means I am not a normal user). In the old days it was defined by email, and before the Web was invented people thought the Internet was synonymous with email. Now – thank you, Tim – they think it is synonymous with the Web. Most people today equate the Internet with Facebook and Twitter, *World of Warcraft*, virtual worlds like Second Life, or Google, or Yelp, where you can go to rate almost anything.

The fact that the Internet can carry packets of bytes between machines anywhere has little to do with the global character of the Internet. What we are concerned with is the experience, not the technology. So, today we are no longer as homogenous as we were in the heady days of John Perry Barlow. We are diverse with respect to language and culture. We are also diverse with respect to

motivation, which is to say we now have a problem we call "bad guys."

Bad guys do all kinds of creepy things, right? They send spam, and they steal credit card data, and they commit fraud and extortion. They sell child pornography, break into companies, steal secrets, destroy computers.

The good guy/bad guy diversity gets all the attention, but I think that diversity in language and culture may be more fundamental. Websites today are localized. Google doesn't look the same in every country. If you search for something in another country, the answers are not just in a different language; you get different answers.

This sort of diversity in the Internet experience has to do with localization of content in order to make it appealing to different people. It is sort of like subtitles in foreign movies. But what does this have to do with sovereignty? Well, the most visible and discussed example of sovereign intervention in the local Internet is China, which is widely known to censor content and shape the Internet experience in many ways.

But I do not want to start by talking about China. Instead let's talk about a country that is closer, both geographically and culturally. France has a law that says it would be an affront to any French person to encounter Nazi memorabilia; it is thus illegal to sell Nazi memorabilia in France. Under that law, France sued Yahoo because Yahoo had an auction page containing Nazi memorabilia that was visible to a French citizen.

Lawsuits were filed in France, as well as in the United States. The countries got into it. It was a horrible tangle, but some interesting issues came up. Yahoo's first defense was, "We can't tell where somebody's coming from. They just show up and download the webpage. We don't know whether they came from France or England or Iran." Well, maybe not. They lost that argument very quickly, because experts brought in by the French government said, "You can tell with reasonable precision. You can't tell perfectly, but if you're already localizing Web content, how can you say you can't tell where somebody's coming from?"

Even more interesting, toward the end of the lawsuit all of the actors, desperate not to create a precedent, backed down. Yahoo's position changed, and they declared, "This is so difficult and tedious and frustrating, we will just stop selling Nazi memorabilia everywhere."

What should we make of that? One answer is that it is no great loss. How many folks care about buying Nazi memorabilia? Of course, if I could produce somebody from the ACLU, they would say, "Remember, it is in the defense of unpopular causes and unpopular speech that we sharpen, refine, and invigorate our own sense of free speech and our First Amendment rights."

The contest between the United States and China over the character of the Internet is far more than just rhetorical. We hear a lot about the Chinese breaking into computers in America. We assume it is the Chinese, but who knows. They steal things, conduct industrial espionage.

That is a rather American comment, and I understand that. But I am still a little uncomfortable that the action of a French court indirectly caused the removal of content in the United States. You might ask, "How many other examples of this are going to happen?" Well, the country of Thailand objected to a YouTube video that was offensive to the king of Thailand. Pakistan objected to a YouTube video that was offensive to Islam, and in the Australian courts a man won a lawsuit for being libeled in an article that would have been quite acceptable in an American newspaper.

How much content is going to be removed from the Internet if the Internet is truly global? We could see these cases as "edge conditions." The Internet mostly works the same in France as it does here. Free speech mostly survives. But clearly, as John Perry Barlow said (although there is some doubt about who said it first), "Freedom of speech is a local ordinance in Cyberspace."

The country that defines the other end of the spectrum is China. The ministry responsible for control of content reports that its productivity has increased to the point where it is removing a million pieces of unacceptable content per day. Here in the United States, this has triggered a certain amount of outrage.

We responded by scolding the Chinese. We said, "You shouldn't do that." Hillary Clinton gave two speeches on U.S. views about the future of the Internet. She called for a global commitment to Internet freedom and offered a passionate, compelling statement of our values: "The rights of individuals to express their views freely, petition their leaders, worship according to their beliefs, these rights are universal, whether they are exercised in a public square or an individual blog." And she went on to say, "The United States supports this freedom for people everywhere, and we have called on other nations to do the same."

Of course our tolerance for diverse speech ends quickly when it violates our

Would we – "we" being the United States and countries with whom we largely share values – be better off if we do not try to force the Internet to be the same everywhere but instead allowed some of the boundaries to be hardened so that we can have the Internet we want at the cost of letting others have the Internet they want?

laws. The difference is that the laws we tend to enforce in this country, as Tim suggested, have to do with the distribution of illicit copyrighted material. I don't know whether we take down a million things a day, but we certainly prevent and suppress large quantities of content on the grounds that it may not be appropriately approved by the copyright holders.

The Chinese have an interesting reaction to this. The Chinese say, "Well, you enforce your laws vigorously. We enforce our laws vigorously. It's completely symmetric. You don't like our laws very much. We don't like your laws very much, either."

Each party is offended and threatened by the laws and actions of the other side. The only difference is that we think our laws are better than their laws. We refer to things like the UN Declaration of Universal Human Rights to make our case.

But the contest between the United States and China over the character of the Internet is far more than just rhetorical. We hear a lot about the Chinese breaking into computers in America. We assume it is the Chinese, but who knows. They steal things, conduct industrial espionage.

What do we do? We defend our values. The U.S. government, particularly the State Department, pays private-sector companies to develop anticensorship content – applications – programs you can run on your computer to try to get around the barriers the Chinese put up. Then we give the software to Chinese dissidents and activists.

The Chinese reaction to this is not, "Oh, you're defending free speech." The Chinese reaction is, "You are engaged in active regime destabilization." They start muttering about cyber war.

Now we are into issues that are above my pay grade. As Tim said, if you want to talk about violations of human rights or how much energy the United States should put into defending commercial copyright holders, those are high-level questions. Because I am here to talk about the future of the Internet, I want to ask a more low-level question. Would we – "we" being the United States and countries with whom we largely share values – be better off if we do not try to force the Internet to be the same everywhere but instead allowed some of the boundaries to be hardened so that we can have the Internet we want at the cost of letting others have the Internet they want?

Would we – not the whole world – be better off? What I just asked is a very dangerous question, because it is ideologically imperfect; it allows for the possibility of pragmatism as opposed to a passionate defense of universal open networks.

The important question to ask is, how is this going to play out? The private sector is largely responsible for many of the things that are partitioning the Internet along regional boundaries. I already mentioned that websites get localized. Another thing that happens, my children report, is that more and more when they try to download legal copyrighted material they get a statement saying, "You cannot download this because it is not licensed for distribution in your country."

All of a sudden we are beginning to see content, especially commercial content, sitting behind country-specific walls. So while at least some of the governments in the world are calling for an open Internet, other governments and the private sector are busy building an Internet with strong jurisdictional-dependent behavior.

Do we care? I think there is an interesting intellectual conundrum here. While we praise the open Internet, we also praise its generality. Tim said, "There was this platform, and I just built the Web on it." I said, "That's great!" Somebody else can come along and build the other Web. And we say, "That's great too!" We love its generality.

But that doesn't mean you have to run the same Web I do. If we can run anything on it, and I choose to run one thing and you choose to run another thing, do I have a complaint? Should anybody object?

Perhaps you have heard of the "Great Firewall of China," which is what the Chinese created to keep out objectionable content. This is not how they remove a million things a day. They do that with people, a lot of people, because it takes a lot of people to remove a million pieces of content a day.

What the Chinese did is to define the Chinese experience by blocking popular applications that we take for granted, like Facebook and Twitter, replacing them with locally developed versions. We run our Facebook. They run their Facebook. We run our Twitter. They run their Twitter. Their applications are tailored for use by Chinese speakers, and they are very popular, but they include tools that can be used to limit unacceptable content and conversation.

So, even if we have a global Internet at the packet level, we have a partitioned Internet at the level of what I would call "the user experience." Does this really matter?

Henry David Thoreau said, "Our inventions are wont to be pretty toys, which distract our attention from serious things. We are in great haste to construct a magnetic telegraph from Maine to Texas, but Maine and Texas, it may be, have nothing important to communicate."

I would say that the partitioning of the Internet, the blocking of Facebook in China, the issue of Nazi memorabilia, and other issues at the edges do matter. But I think most Chinese and most Americans are not bothered by the fact they can't friend each other on Facebook. If you are trying for a stretch friend, you can find one in Russia and in many other countries, but you will discover you can't find a stretch friend in China. To a small set of people, this is a real loss and something worth fighting for.

The question we should ask ourselves is, "In arguing for a global Internet, in fighting for the Internet we want, what price does the Internet itself pay?" The price could be high.

The Internet today is largely governed and constructed by the private sector, the Internet service providers, the companies like Akamai that get together and build the Internet. But a lot of countries, including China, are uncomfortable with this, and have argued that government should be in charge of the Internet.

The International Telecommunications Union, or ITU, is a regulatory division of the United Nations. A long time ago it defined the rules by which telephone systems connected internationally. Before that, it defined the rules by which telegraph systems connected internationally. Their charter specifically precludes them from having governance responsibility of the Internet. But in December 2012, in Dubai, they will hold a plenipotentiary meeting at which they are going to change their charter to give themselves governance of the Internet.

The ITU is a treaty organization, which means that when pronouncements are voted on, each state gets one vote. Further, the presumption is that because of the treaty, countries will pass local laws that translate ITU pronouncements into national obligations. So, what they are trying to do is regulate the character of the international connections that make up the global Internet.

There are a variety of reasons they want to do this, and one of them is very painful. In part it has to do with the Chinese preference for having a much more regulated Internet, and in part it has to do with money. An economist friend of mine told me that to understand the future of the Internet, you have to remember that the Internet is about routing money. Routing packets is a side effect. I said, "We didn't design money-routing protocols." And he said, "You really screwed up."

In the old telephone system, when I called your country, the telephone company in my country paid your telephone company to deliver the call. This was called a "termination charge." Maybe you remember when international phone calls cost a dollar a minute? It probably cost them three cents a minute to terminate that call.

Where did the rest of the money go? Well, telephone companies belonged to the states. The money flowed into the general coffer. In the developing world, it was a major source of hard currency. But Skype has killed that money flow. Now they are really annoyed. So they get this clever idea: Why don't we regulate international connections so that when I send packets to you, I have to pay you to deliver them, and you get to set the rate.

If this happened, it could fracture the Internet even more profoundly than the Great Firewall of China. Think about Tim's comment about open data. We should give it away freely. But can I really afford – as MIT with Open Courseware or a government with open data – to make that data available if I have to pay not only for the computer that attaches to the Internet but a termination fee as well to deliver my data to a foreign country?

This is a worst-case story; it may not work out this way. But I find it an utter travesty of the vision of the Internet that some of us talk about its power to transform society through its open access to information and other people think of it as a machine for pumping money into the developing world.

I think the Internet will continue to be a vitally important tool for society, but, pessimistically, I think a number of countries will not buy into the religion. They are going to take steps that will greatly impair the value of the Internet.

Therefore I ask the pragmatic question, which is dangerous because it is ideologically not extremist; it doesn't advocate openness before everything else: Should we be careful to protect the Internet we want, picking our fights so as not to compromise that goal even as we argue for the ideal of the global open Internet? If in the end we discover we are not getting a lot of traction globally, we should simply say, "Fine, we will have the Internet *we* want." ■

To view or listen to the presentations, visit http://www.amacad.org/events/EvolutionOfTheInternet/.

Cyber-Archaeology and World Cultural Heritage: Insights from the Holy Land

On January 25, 2013, at the 1992nd Stated Meeting of the Academy, **Thomas Levy**, Distinguished Professor and Norma Kershaw Chair in the Archaeology of Ancient Israel and Neighboring Lands at the University of California, San Diego (UCSD), described "cyber-archaeology" and the important role it plays in helping to promote excellence in the humanities and social sciences. The meeting was called to order by **Gordon N. Gill**, Vice Chair of the Western Committee of the American Academy and Professor of Medicine and of Cellular and Molecular Medicine Emeritus at the University of California, San Diego School of Medicine. **Pradeep K. Khosla**, Chancellor of the University of California, San Diego, welcomed the audience. The meeting took place at the Qualcomm Institute for Telecommunications and Information Technology, the UC San Diego Division of Calit2. Levy's presentation and the introduction given by **Charles S. Stanish**, Director of the Cotsen Institute of Archaeology and Professor of Anthropology at the University of California, Los Angeles, follow.

"Scientific archaeology today is now able to tease out some of the most fascinating details in the social evolution of our species."

– Charles S. Stanish, Director of the Cotsen Institute of Archaeology and Professor of Anthropology at the University of California, Los Angeles

Charles S. Stanish

Charles S. Stanish is Director of the Cotsen Institute of Archaeology and Professor of Anthropology at the University of California, Los Angeles. He was elected a Fellow of the American Academy of Arts and Sciences in 2006.

Introduction

The image of the archaeologist as merely a collector of objects is an old one, and this unflattering image unfortunately describes our field in the eighteenth and nineteenth centuries. About a hundred years ago, however, archaeology grew into a systematic natural history, a discipline that straddled the humanities and sciences. Fifty years ago the field continued to evolve with one branch now constituting a comparative behavioral and social science. Scientific archaeology today is now able to tease out some of the most fascinating details in the social evolution of our species.

Many people are amazed to learn that we can now describe with great accuracy the diet of people who lived 10,000 years ago by applying techniques such as isotopic residue analysis and X-ray diffraction to stone tools. We can trace the evolution and history of disease using DNA. We can track human migration by measuring ratios of strontium in people's teeth and ribs. We can recreate ritual processions using virtual modeling. We can define the effects of human beings on plant and animal evolution by measuring genetic changes. We can model the acoustics of a 5,000-year-old temple using engineering principles. We can detect minute changes in the local climate by analyzing pollen cores from bogs and lakes, and we can define the strategies that people utilized to cope with such changes using agent-based modeling. These and countless other facts about our ancestors help us more fully understand social evolution. All of these innovations have been driven by new technologies that allow us constantly to expand our ability to dig deeper to discover new data.

Professor Thomas Levy represents the best of this tradition, being first a great field archaeologist and accomplished theoretician who understands the *appropriate* role of technology in science and model building. Too many of our colleagues find a really nice toy and then try to find the scientific questions to fit it. Tom, one of the few among us who has eagerly grasped the potential of these new technologies, understands that you have to use the appropriate technology for the appropriate research design. Tom is Distinguished Professor and Norma Kershaw Chair in the Archaeology of Ancient Israel and Neighboring Lands at the University of California, San Diego. He is also a member of the Department of Anthropology and the Judaic Studies Program, and he leads the Cyber Archaeology Research Group at the Qualcomm Institute for Telecommunications and Information Technology, the UC San Diego Division of Calit2.

Elected to the American Academy in 2008, Tom is one of the leading archaeologists interested in the role of technology and social evolution. He not only uses technology, he studies it. He is particularly interested in early mining and metallurgy and is a leading theorist of modeling human social interactions from the beginning of what we call the sedentary life of our species, around 9,000 years ago, to the rise of the first historic Levantine state societies in the Iron Age circa 1200 BCE. He is a Fellow of the Explorer's Club, and he won the 2011 Lowell Thomas Award for exploring the world's greatest mysteries. He has been the principal investigator on numerous interdisciplinary archaeological field projects in Israel and Jordan funded by many institutions, including National Geographic, the National Endowment for the Humanities, and the National Science Foundation, as well as by private donors. Tom also conducts contemporary research in India with his wife, Alina Levy. They recently coauthored *Masters of Fire: Hereditary Bronze Casters of South India*. Tom has published ten books and several hundred research articles. His most recent book, *Historical Biblical Archaeology: The New Pragmatism*, won the Best Scholarly Book Award from the Biblical Archaeological Society.

Thomas Levy

Thomas Levy is Distinguished Professor and Norma Kershaw Chair in the Archaeology of Ancient Israel and Neighboring Lands at the University of California, San Diego. He was elected a Fellow of the American Academy of Arts and Sciences in 2008.

Presentation

Toward the end of 2010 members of the U.S. Senate and House of Representatives issued a bipartisan call for the American Academy of Arts and Sciences to respond to the following question:

> What are the top actions that Congress, state governments, universities, foundations, educators, individual benefactors, and others should take now to maintain national excellence in humanities and social scientific scholarship and education, and to achieve long-term national goals for our intellectual and economic well-being; for a stronger, more vibrant civil society; and for the success of cultural diplomacy in the 21st century?

Today, my graduate students, colleagues, and I are helping to demonstrate how archaeology, as practiced at research universities in the United States, can help respond to this bipartisan call.

Specifically, interdisciplinary collaborations here at UCSD among faculty, graduate students, and undergraduates working on international projects are developing a twenty-first-century version of archaeology, what I like to call "cyber-archaeology." It can play an important role in helping to promote excellence in the humanities and social sciences by addressing scholarship that focuses on world cultural heritage.

We should remember that, like natural resources, cultural resources are limited. As scholars, our responsibility is to conduct research, but also to disseminate information to promote national and international pride in cultural heritage and help facilitate national and international efforts that harness cyber-archaeology for conservation and tourism needs.

We should remember that, like natural resources, cultural resources are limited.

In 1994 UNESCO's World Heritage Committee launched a global strategy for a representative, balanced, credible World Heritage List for the protection of cultural and natural sites. Today, 962 properties around the world, including 745 cultural, 188 natural, and 29 mixed properties, have passed the rigorous nomination process. Examples in the United States include Mesa Verde National Park, Yellowstone, and Hawaii Volcanoes National Park. In the United Kingdom, Stonehenge, the city of Bath, and the old and new towns of Edinburgh come to mind. In Jordan, where I work, the Nabataean rose-red city of Petra, seen in the Indiana Jones movie *The Last Crusade*, is the most famous on the list. My research area in Jordan, which is 30 kilometers northwest of Petra, is now on the list to become a UNESCO biosphere reserve.

While natural resources often have a chance for renewal, this is not the case with cultural resources. They are always in danger of destruction from natural processes and human actions – actions such as the recent pillaging of Sufi Islamic heritage in Mali and the Taliban's destruction of the famous Bamiyan Buddha statues in Afghanistan in 2001.[1] The Afghan government has been working with cyber-archaeologists to use laser scans to reconstruct the massive Bamiyan statues.[2] This is just one of the ways cyber-archaeology can offer answers to issues raised by researching and conserving cultural heritage. In fact, cyber-archaeology offers answers not only for archaeology but for other field sciences, including geology, ecology, biology, oceanography, and more.

Cyber-archaeology refers to the integration of the latest developments in computer science, engineering, science, and archaeology. UCSD is uniquely situated to help advance cyber-archaeology because of its unparalleled, interdisciplinary research focus, as exemplified by the Qualcomm Institute for Telecommunications and Information Technology, the UC San Diego

[1] On the destruction in Mali, see Emily O'Dell, "Slaying Saints and Torching Texts," *Jadaliyya*, February 1, 2013, http://www.jadaliyya.com/pages/index/9915/slaying-saints-and-torching-texts.

[2] Claudio Margottini, ed., *After the Destruction of Giant Buddha Statues in Bamiyan (Afghanistan) in 2001* (New York: Springer, 2013).

The Harvard Business School is using the Qualcomm Institute, the UC San Diego Division of Calit2, as a case study of how the twenty-first-century research university should be structured.

Division of Calit2. Within the institute, I am part of a $3.2 million grant awarded by the National Science Foundation's Integrative Graduate Education and Research Traineeship Program, otherwise known as IGERT. My colleague Falko Kuester, a structural engineer and computer scientist from UCSD's Jacobs School of Engineering, is principal investigator. Talented faculty, students, and staff working with powerful computer-based analytical facilities in Calit2 enable us to explore new directions in research, scholarship, and teaching.[3]

The Harvard Business School is using the Qualcomm Institute, the UC San Diego Division of Calit2, as a case study of how the twenty-first-century research university should be structured, and it points to the unique academic atmosphere we enjoy here. With regard to cyber-archaeology, our graduate students are harnessing the power of the information technology revolution to answer high-level research questions facing the humanities and social sciences. My own archaeological research in Jordan and Israel is rooted in an interdisciplinary approach that straddles anthropology, Judaic studies, history, computer science, and engineering. Over the past six years, my engagement with Calit2, and specifically with its Center of Interdisciplinary Science for Art, Architecture and Archaeology (CISA3), where I am Associate Director, has dramatically changed how we think of archaeology. The Director of the Qualcomm Institute, the UC San Diego Division of Calit2, Ramesh Rao, has encouraged us to develop cyber-archaeology as a distinct, twenty-first-century approach to the study of world cultural heritage.

At UCSD and other research universities in the United States, scholars in the social sciences cannot rest on the twentieth-century achievements that made these institutions the best in the world. In its letter to the American Academy of Arts and Sciences, Congress stated that it is concerned that the tradition – and here I suggest, the tradition of great achievements in the humanities and social sciences that began in the twentieth century – is at risk. This puts the unique American character at risk as well. As pragmatists, social science researchers in the United States must engage with the digital revolution to make their research relevant and useful to solve problems. My UCSD political science colleague James Fowler, who is also in the UCSD School of Medicine, recently carried out an experiment on Facebook that focused on Election Day in November 2012. He sampled 61 million Facebook users. This is a great example of twenty-first-century social science research. However, while there is such a thing as the digital humanities, you rarely hear the term *digital social sciences*. Yet cyber-archaeology harnesses the benefits of computer science

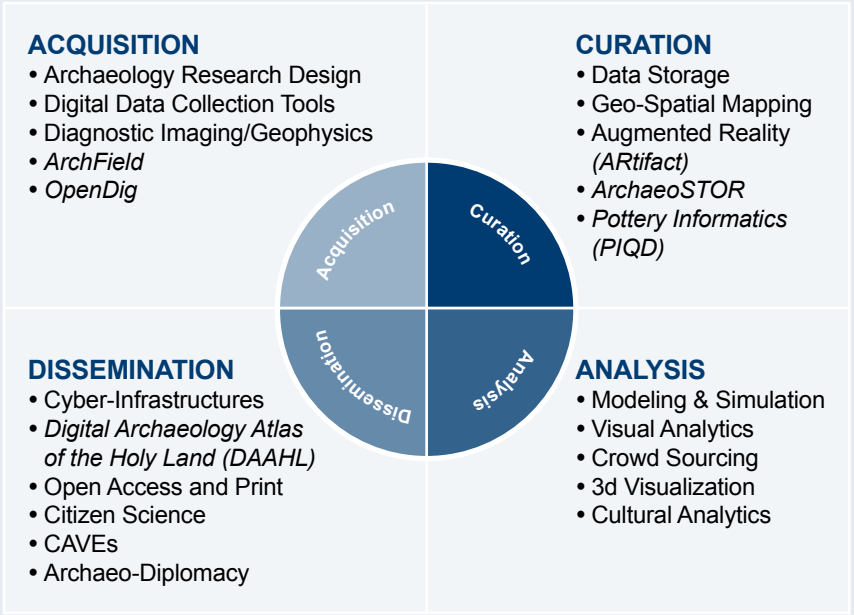


Figure 1. Workflow model for cyber-archaeology developed at the University of California, San Diego. The model is applicable to any field science.

[3] Thomas E. Levy, Neil G. Smith, Mohammad Najjar, Thomas A. DeFanti, Albert Yu-Min Lin, and Falko Kuester, *Cyber-Archaeology in the Holy Land: The Future of the Past* (Washington, D.C.: Biblical Archaeology Society eBook, 2012), http://www.biblicalarchaeology.org/get-ebook/?download_this_freemium=20844.

and engineering to tackle the needs of world cultural heritage research and conservation, and I believe that cyber-archaeology can contribute to building "digital social sciences" here at UCSD.

To conceptualize what cyber-archaeology is all about, think of it as a pie chart (see Figure 1). Basically, it involves the acquisition, curation, analysis, and dissemination of data. This is common to all field sciences, but our work in cyber-archaeology provides a model for the present and the future. In terms of acquisition, what drives research is the set of humanistic and social science questions that we want to answer.[4] That is where it all begins.

In our research group, we have focused on developing digital data-collection tools that can be used in the field. Diagnostic imaging and geophysics are also employed. One of our graduate students, Matt Vincent, is developing a program called OpenDig to collect all of the metadata involved in excavating an archaeological site and then serve up that data on a smartphone, tablet, or similar device.

Curation of data involves data storage, geospatial mapping, and augmentation (so-called augmented reality, or AR). Another student, David Vanoni, adds metadata to visual imagery of cultural and historical sites using AR, and Aaron Gidding is responsible for creating ArchaeoSTOR, a relational geospatial database system.

Many of these areas of acquisition and curation are crosscutting; thus, data are used for modeling. We use a wide range of visual analytical tools, and graduate student Andrew Huynh, working with CISA3 researcher Albert Lin, develops online crowd-sourcing solutions that can bring thousands of citizen scientists into the loop.

Visualization is exciting because it allows you to look at cultural artifacts in new ways, and visualization is critical to dissemination because we need to make our data available to our colleagues as well as to the general public.

Thus, cyberinfrastructure is critical for archaeology, and it must be made available for free through an open-source, open-access system. Publishing our results in peer-reviewed journals and books is still crucial. However, other modalities exist for disseminating data arising from twenty-first-century cyber-archaeology. At the Qualcomm Institute, the UC San Diego Division of Calit2, we have 3-D visualization environments, called CAVEs, and we have helped build CAVEs in Saudi Arabia. These efforts represent "archaeo-diplomacy," because they enable us to create partnerships that make our teams cultural diplomats for the United States in distant lands.

Cyber-archaeology harnesses the benefits of computer science and engineering to tackle the needs of world cultural heritage research and conservation.

From UCSD, we have carried out a number of cyber-archaeology expeditions in Greece, in Cyprus, and in the Middle East, especially in Jordan, where I work most closely. Our CISA3 team also has projects in Mongolia, Saudi Arabia, and Italy. In Cyprus, I have been involved in a paleomagnetic-dating project with Lisa Tauxe, a professor at UCSD's Scripps Institution of Oceanography. However, archaeometallurgy is the main focus of our research in Jordan, Israel, and Palestine.

Our principal cyber-archaeology field research is in southern Jordan, in a region called Faynan (after Biblical Punon). That is where, since 1997, I and Jordanian archaeologist Mohammad Najjar have been conducting a deep-time study of the role of technology – in this case, ancient mining and metallurgy – on the evolution of societies. We begin in the Neolithic period (ca. 8,000 BC), work through the urban revolution in the Early Bronze Age (ca. 3000 – 2000 BC), on to the Iron Age (roughly 1200 – 500 BC, which is the Biblical period from the time of the Exodus to the destruction of the Temple in Jerusalem), and then to medieval Islamic times. The first local, historic, state-level societies emerged in this region during the Iron Age (ca. 1200 – 500 BCE).

An aerial image depicts the largest (ca. 24 acres) Iron Age metal factory in the Faynan district, located 50 kilometers south of the Dead Sea. Black slag still covers the surface. A large square structure represents a fortress, and we use ancient metalworking as a kind of proxy to measure social change. We look at the organization of craft production, its context, concentration, and scale of production. This informs us about social organization, and data can also be related to historical sources associated with the ethnogenesis of early Israel, the Edomites, and other peoples connected with this story.

In 1999, several years after I first started to work in Jordan, a friend said, "Why don't you send a fax to Queen Noor and ask her if she could provide you with a helicopter to do some aerial photography?" Queen Noor was born an American and was married to King Hussein. It took some chutzpah, but I sent her the fax and she responded. "Be at the Marka Air Base on such and such a day, and the Royal Jordanian Air Force will fly

[4] Kent V. Flannery and Joyce Marcus, *The Creation of Inequality: How Our Prehistoric Ancestors Set the Stage for Monarchy, Slavery, and Empire* (Cambridge, MA: Harvard University Press, 2012).

you around for a day." That is when we took our first amazing images around Faynan. However, the experience left me wanting my own aerial photography and mapping system. That dream finally came true ten years later, after I started to collaborate at the Qualcomm Institute.

For archaeologists, and probably for most field scientists, time and space are our most precious commodities. Time because it enables us to measure cultural change, for which we use high-precision radiocarbon dating and Bayesian analysis. Space because we need to know the spatial location of every artifact we find. If you remove an artifact from its context, it has no social meaning. But if we know its setting, then we can begin to build meaningful models of the past. Our group has developed a "digital toolbox" that can be deployed in the field. Total stations and GPS are used to collect precise *x*, *y*, and *z* coordinates that pinpoint the location of every cultural artifact. Aerospace engineering students as part of UCSD's undergraduate National Geographic Engineers for Exploration program developed a helium balloon system for high-definition aerial photography (see Figure 2). We can use video over Wi-Fi if we want to see what the cameras see from the balloon's undercarriage while deployed above the dig site. We use portable X-ray fluorescence instruments to characterize artifacts, 3-D scanners to scan each significant artifact we find, and a 3-D visualization system to display the results.

In November 2012, the American Center of Oriental Research (ACOR) asked if we would partner with them on a two-day cyber-archaeology expedition in the area to create georeferenced aerial photographs, 3-D maps, LiDAR, and AR of the center of Petra. The results were astounding thanks to the graduate students who were with us in the field for this project, which was carried out in partnership with Jordan's Department of Antiquities. We developed a system for 3-D "rescue laser scanning" with Ashley Richter, using software developed by another student, Vid Petrovic. Figure 3 shows the iconic Treasury (*al-Khazneh* in Arabic), considered the most magnificent of Petra's sights, as visualized with our software.[5] Here, LiDAR is used as a conservation tool, which is how most people today use LiDAR, because it collects millions of georeferenced data points that together portray exactly what an area looked like on the day it was scanned. Since that date, the area may have degraded, and by comparing LiDAR scans from two time periods, we can learn a lot about the rate of decay – and begin to consider ways to counteract it.

Figure 2. Helium balloon platform flown at Jordan's Petra UNESCO World Cultural Heritage site by Matt Howland. The balloon system was developed by undergraduate students as part of the UCSD National Geographic Engineers for Exploration program (Photo: T. E. Levy).

At Khirbat en-Nahas (Arabic for "ruins of copper"), our site in the Faynan district in southern Jordan, our students carried out three weeks of LiDAR scanning with Tom Wypch. We wanted to date the fortress by 3-D plotting high-precision radiocarbon dates in relation to walls and layers we excavated at the site. Vid Petrovic's program essentially created a scaffold on which we could embed different kinds of archaeological spatial data. By doing this, we could see when the foundation of the monumental fortress came into existence. From this, we now know definitively that it was constructed in the tenth century BC. This is interesting because many scholars have said that no local complex societies existed in the southern Levant during that century; that

[5] We are grateful to Jehad Haroun and Tawfiq al-Haiti of the Department of Antiquities for sharing these LiDAR data.

would mean that there was no impressive Solomonic or Edomite kingdom, for example. What we proved was that, yes, impressive, local state-level societies capable of building fortresses like Khirbat en-Nahas *were* present in the desert zone during the tenth century BC.

In the area of curation, we have integrated data storage, geospatial mapping, and augmentation with the program ArchaeoSTOR. This helps us record and organize data both in the field and when we get back home. Measured in gigabytes since 2007, our collection of digital data has grown exponentially from 172 GB to 2,055 GB in 2011. Last fall, the volume of data went down slightly, but that is because data storage is not really our big problem. Today, you can go to the campus bookstore and buy a two- or three-terabyte drive for a few hundred dollars. The hard part is taking the disparate kinds of field data and melding them together to test your hypothesis. So we have been working with the UCSD-based San Diego Supercomputer Center and the UCSD Libraries in their Research Cyberinfrastructure program.[6] Our lab is one of their five pilot projects. What we all have in common is an interest in the geospatial organization of data, whether massive sets of seismic data, deep-sea cores from oceans around the world, or thousands of artifacts geospatially organized from our excavation sites. Thus, all field sciences deal with the same problem.

Internet connectivity is difficult when you are working in a remote desert area such as our sites in southern Jordan. ArchaeoSTOR, a kind of cloud-based service model, basically mirrors the Web until we get back home.

How can we bring all these kinds of data together to help solve specific historical problems? When we were digging at Khirbat en-Nahas, we decided to sample one of the slag mounds by excavating a large (greater than 5-by-5-square-meter) area down to bedrock. We went down more than 24 feet, layer by layer, collecting artifacts, slag, and organic remains for high-precision radiocarbon dating. This stratigraphic "core" enabled examination of the intensity of metal production through time. It became clear that we were looking at industrial-scale copper production over a very short period of time: the tenth and ninth centuries BC. Yet we had over two-and-a-half meters of industrial slag for each radiocarbon-dated century – indicating that a complex society (kingdom/archaic state) was processing metal. The artifacts showed that it was a local Levantine society – not from the neighboring centers of Egypt, Mesopotamia, or Anatolia. So again we have shown that in the tenth century BC, in the Biblical time of Solomon, the early Israelites and Edomites, local kingdoms were involved in these activities. We first published these interdisciplinary findings in the *Proceedings of the National Academy of Sciences* in 2008.[7]

Figure 3. LiDAR model of the Petra Treasury, enhanced with Calit2 graduate student programming (data courtesy of the Jordanian Department of Antiquities).

Dissemination of cyber-archaeology involves issues such as open access, citizen science, and archaeo-diplomacy. One collaboration in this area is between Calit2 and King Abdullah University of Science and Technology (KAUST) in Saudi Arabia. KAUST wanted to build something like the MIT Media Lab or the Qualcomm Institute, with visualization environments for large-scale or 3-D immersive visualization and

[6] For information on this project, see http://rci.ucsd.edu/data-curation/pilots.html.

[7] Thomas E. Levy, Thomas Higham, Christopher Bronk Ramsey, Neil G. Smith, Erez Ben-Yosef, Mark Robinson, Stefan Münger, Kyle Knabb, Jürgen P. Schulze, Mohammad Najjar, and Lisa Tauxe, et al., "High-Precision Radiocarbon Dating and Historical Biblical Archaeology in Southern Jordan," *Proceedings of the National Academy of Sciences* 105 (43) (2008): 16460 – 16465.

Perhaps we will now witness the advent of "digital social sciences."

virtual reality. Calit2's bid was accepted, and my colleague, and Calit2's director of visualization, Tom DeFanti, led the successful effort to build scientific visualization facilities at KAUST, many of which were completed in time for the university's grand opening in 2009. This was an excellent example of inventing a persistent collaborative research and education environment as a model for the major research university in the twenty-first century, which is what the Saudis wanted.

People instinctively understand archaeology and history; it resonates with them. So, to demonstrate the power of 3-D scientific visualization at the KAUST opening in 2009, we used our Jordanian data in the new visualization lab to highlight cultural heritage research. We demonstrated a 3-D fly-through of the deepest slag section at the Jordanian site, allowing visitors to experience a visual representation of thousands of artifact data points captured in that excavation and compiled by our graduate student Kyle Knabb.

We have also been developing the Mediterranean Archaeological Network, or MedArchNet, with Stephen Savage from Arizona State University. This cyberinfrastructure project is a work in progress, and we envision having a number of digital atlas "nodes" of the network around the Mediterranean. The infrastructure would house geospatial data and other information about the antiquities of countries in each region, all accessible through a Web portal. We have already created the Digital Archaeological Atlas of the Holy Land (DAAHL), which covers Israel, Jordan, and the Palestinian Territories. At UCSD alone, we have amassed 30 tons of artifacts. Another eight tons of material are in transit from Aqaba to UCSD. We don't know where we are going to put it all, but DAAHL enables us to share the data online over a Google Earth georeferenced platform in a virtual museum.[8]

In conclusion, cyber-archaeology provides an integrated approach to dealing with the essential processes associated with field science: data acquisition, curation, analysis, and dissemination. By engaging with the study of many of the major transformations in human history, interdisciplinary archaeology is one of the few disciplines that intersects not only with the humanities and social sciences but with the hard sciences, engineering, and even the health sciences (e.g., in the form of ancient DNA). Since the end of the Pleistocene, around 10,000 BC, humankind has been transformed by a wide range of technological revolutions, among them the Neolithic revolution, the metals revolution, the Industrial Revolution, the information technology revolution, and more. Some argue that today we are in the midst of a nanotechnology revolution. Archaeology's special focus on the material world of human culture has made it pre-adapted to engage with the digital revolution, thanks to the benefits that data mining, scientific visualization, and other IT tools are bringing to scholarly research, exploration, and society.

With the exponential increase in the global use of digital technologies, including cell phones and the Internet, it is essential that in the United States the humanities and social sciences incorporate digital technologies as integral parts of our pedagogy, research, and outreach if we are to maintain excellence in these fields in the twenty-first century – and respond to Congress's appeal to the Academy. Perhaps we will now witness the advent of "digital social sciences." At UCSD, our researchers are collaborating through cyber-archaeology to help maintain national excellence in enhancing international cultural heritage – an area that unites the humanities and the social sciences. Through best practices, we believe our work also contributes to cultural diplomacy by utilizing the most advanced digital tools available for testing cultural and historical questions. ■

[8] To view the atlas, see http://daahl.ucsd.edu/DAAHL.

To view or listen to the presentations, visit http://www.amacad.org/events/statedmeetings/cyberarchaeology/.

The Future of Energy

At a meeting sponsored by the American Academy of Arts and Sciences and the Royal Society, Academy Fellow **Robert Rosner**, William E. Wrather Distinguished Service Professor in Astronomy and Astrophysics and in Physics at the University of Chicago, and Royal Society Fellow **Peter Littlewood**, Associate Laboratory Director for Physical Sciences and Engineering at Argonne National Laboratory and Professor of Physics at the University of Chicago, offered their views on the future of energy. The symposium was the second program in a lecture series on 'GREAT Science,' organized by the U.K. government's Science and Innovation Network to profile international science excellence. Academy Fellow **Robert Fefferman**, Dean of the Physical Sciences and the Max Mason Distinguished Service Professor of Mathematics at the University of Chicago, moderated the program. The meeting took place on November 1, 2012, at the University of Chicago. The following is an edited transcript of the presentations.

> "In the United States, it is widely acknowledged that our energy security, our national security, and our economic security depend on having an innovative and agile manufacturing capability. And *that* depends on having access to energy."
>
> *– Robert Rosner, William E. Wrather Distinguished Service Professor in Astronomy and Astrophysics and in Physics at the University of Chicago*

Peter Littlewood

Peter Littlewood is Associate Laboratory Director for Physical Sciences and Engineering at Argonne National Laboratory. He also holds an appointment as Professor of Physics in the James Franck Institute at the University of Chicago. He is a Fellow of the Royal Society.

If we did have efficient energy capture from sunlight, and had efficient storage, efficient transmission, and efficient use in lighting, refrigeration, motors, and the like, we would be in a very good situation.

The Royal Society is very proud of itself and is rightly considered to be one of the great societies of the modern era. Its history is very practical. In founding the society in 1660 after the restoration of the monarchy, King Charles clearly wanted to make sure he was in charge of these unruly academics and could get them to do useful things for him.

And quite rapidly, the Royal Society got involved in giving out research grants. One of my favorites was to Christiaan Huygens, the Dutch physicist who, I think, was the second foreign member of the Society. His funding, which today we would call a military research grant, was to work on clocks.

At the time, it had already been recognized that if you had a good clock, you could figure out where on the planet you were – useful when you wanted to invade another nation. And the British navy was winding up to start doing just that kind of thing. (Amusingly, at this time Britain and Holland were frequently at war, and here was Huygens sitting in Holland taking English money!)

Huygens was trying to build very accurate pendulum clocks, and in order to do so he constructed them in pairs. This was the only way of checking how good they were. By building two identical clocks, he would be able to tell if the time they were keeping was slightly different, and that would enable him to judge how well they were working.

Huygens built his clocks in a common frame, so they really were identical. What he discovered was that they were also coupled. He noticed that, although they did not normally beat at exactly the same time, when the air was very still in the room, they synchronized.

This was an enormous intellectual breakthrough, the foundation for much of modern linear dynamics, for the basic understanding that goes into lasers, superconductors, and so on.

Unfortunately, it was a bit ahead of its time. When Huygens reported his discovery to the Royal Society (the paper was read to the assembled multitude), they were not very impressed. The response was, "We asked you to build accurate clocks, but your clocks are so bad that one clock can influence the time of another."

So, not only was the research grant not renewed; the Society actually lost Huygens's paper. About a century later it was discovered in the basement and was finally published around 1780. At this point, I am not sure whether the Society set science forward or backward!

Until about 200 years ago, we lived moderately sustainably on the planet, at least by modern terms, because most of the energy came from the sun, usually in the form of food, and work meant the physical labor of human beings or of a horse or ox.

The Industrial Revolution, however, was, not accidentally, powered by fossil fuels. But within about a century or so we will have to change our behavior. And we don't want to return to the age of the horse and cart.

Now, I am not going to talk about climate, I am not going to talk about nuclear energy, and I am not going to talk about fusion. Nor am I going to talk about policy. What I do want to do is to raise some issues about renewable technology for energy generation, storage, transmission, and use.

I think it is worth trying to adopt a posture which assumes that we have solved these problems and can look back and figure out how we got there. I am a theoretical physicist, and this is the kind of thing that theoretical physicists like to imagine.

The goal will be that we have electrification as widely as possible, and the reason for that is physics. A certain amount of energy comes from the sun, and we want to be as efficient and as effective with it as possible. I want to have the lowest possible number of conversions between the source and the use. My view is that the best thing to do is to turn photons into electrons, moving them around because they are very light.

If we did have efficient energy capture from sunlight, and had efficient storage, efficient

transmission, and efficient use in lighting, refrigeration, motors, and the like, we would be in a very good situation. Can we do it?

A second point is that energy is money. We often talk about the cost of energy, but two centuries ago everything was priced in terms of its energy input. In medieval times, the standard unit was the cost of a workman's labor.

For a very short period in our history, energy was free, and that colored our technologies and the way our society works. But energy is no longer free, and we might begin to think about it as if it were actually a currency.

How close are we to that? Well, take the example of a wind turbine. You can buy a wind turbine for about $10 million – an Enercon E126, which is actually a wind turbine with a 126-meter wingspan; it is a big object. Rated at 7.5 megawatts and weighing 6,000 tons, it costs, at $10 million, $1.50 a kilogram. That is the right way to think of things like this.

I can imagine a very simple device made from two different materials, ten nanometers thick, put together so it has an internal electric field and is called a ferroelectric, which will absorb the solar spectrum efficiently, will separate the carriers, and will store them in situ at an energy density approaching that of gasoline.

The reason it is this simple is that wind turbines are made of stuff. Steel costs about $1.00 a kilo, aluminum is about $2.50 a kilo, and the cost of both of those is principally the cost of the energy that goes into them. In the case of steel, the energy cost is about one-third of the overall cost. For aluminum, it is more than one-half of the cost.

Incidentally, if you want to figure out how much to pay for something, you can apply the "hamburger rule": weigh the item and multiply it by the cost of hamburger, and you will get roughly the right answer – that is because hamburger is also energy.

Having a wind turbine, you can work out that if you run it at 35 percent efficiency and sell your electricity at about $0.10 per kilowatt hour, it will pay for itself in three to four years. That is why you see lots of wind turbines. (By the way, I could have done that return on investment not by going from dollars to energy to dollars but by going from energy to energy, energy in to energy out.)

As we approach what I think of as asymptopia, when the price of things converges on the price of the energy cost going in, those calculations would be much more sensibly done in terms of energy, but this works best if we have efficient markets in energy. Otherwise, we deal with currency volatility, which is driven by the fact that, because energy is actually a rather stable commodity, valuing it in terms of dollars, pounds, gold bars, or whatever is hard.

Another way of considering the matter is to decide how you would like your pension to be paid. Would I like Treasury bills or dollars, or would I like to be paid in kilowatt-hours? I would rather have the latter; it would be useful.

So now, the question is, "How much energy is there, and how much do we use?" The solar input, the amount of energy arriving at the top of earth's atmosphere, is approximately 345 watts per square meter. That is what gets converted to heat, to wind, to waves, and to rainfall. Just about the only renewable that is not driven that way is tides.

U.S. energy use is about three terawatts. That is five billion microwave ovens or the solar flux on 10,000 square kilometers, which is about the area of Delaware and Rhode Island.

If we look at U.S. energy intensity, how much energy is used per square meter, it is actually 0.3 watts per square meter on average. Big country, a lot of energy use, but 0.3 is a relatively low number. That is one part in 1,000 of the solar energy which is incident on the United States. It is actually about the same number as India and China, but for very different reasons.

In the United Kingdom the number is two watts per square meter, about an order of magnitude bigger. In a densely populated city-state like Singapore, the number is fifty. Go in the other direction, to a country like Brazil, it is 0.03.

Singapore is going to be importing energy forever, whereas Brazil has relatively low-cost, straightforward solutions such as low-intensity biofuel. In short, different levels of energy density mean different energy policies for different countries.

If you want to get solar energy, the best technology is a nineteenth-century one, a parabolic mirror and a steam engine, which will, in good condition, generate twenty watts per square meter on average. (That is twenty coming out of the 345 that came in.) Current best technologies in solar photovoltaic are lower, around five to six watts per square meter. Wind energy is mostly mixed up with thermal energy, so the energy intensity is about the same.

Rainfall and dams are about one to two watts per square meter where they exist, and we have already used up most of those sites. Wave is negligible in the United States but

actually quite important to a country with a long coastline and small land area, like the United Kingdom. Biofuels range from three or four watts per square meter to minus two for some ethanol programs. In contrast, if you take a nuclear power station, you can get ten gigawatts on a square kilometer, or 10,000 watts per square meter.

So, if you want to use renewables, they have to be deployed on a country-size scale. Practical applications of these technologies are going to take up something like 5 – 10 percent of the U.S. land area – that is the combined area of New Mexico and Arizona.

A separate issue, one about which people get confused sometimes, is cost. It is possible to make a positive return on investment with current technologies. Wind is going up relatively rapidly. Photovoltaics are different, but at $1.00 per kilowatt hour, which is roughly where we are heading, you get a payback in around three or four years. With our current biofuels, it is possible to make money but at the cost of raising the price of food.

The reason that some of these technologies are not more common is that they do not scale. In 2011, solar photovoltaics installation in the United States was ten square kilometers, which sounds like a lot but is about the size of the Phoenix airport. What is needed is something on the scale of 10,000 square kilometers.

Doing that would cost a few trillion dollars, so we could actually afford it, but we could not manufacture the stuff to make it work. We are in a kind of forced market for photovoltaics because, for slightly obscure reasons, we are at a point where we could make money out of it, but there is no way it could make a dent with current technologies. Not to mention the substantial interlocking issues associated with the grid, with storage, and with everything else.

Jumping forward a century, I am absolutely confident that the science problems will have been solved. Nothing in the laws of thermodynamics stands in our way. For example, I can imagine a very simple device made from two different materials, ten nanometers thick, put together so it has an internal electric field and is called a ferroelectric, which will absorb the solar spectrum efficiently, will separate the carriers, and will store them in situ at an energy density approaching that of gasoline.

Electrical storage is an important part of a renewable portfolio because it is necessary for the successful introduction of other technologies. You cannot have wind power unless you know what to do when the wind is not blowing. And you cannot have solar power unless you know what is going to happen when the sun goes behind a cloud.

I am pretty confident that such a device is possible, but I have no way of manufacturing it cheaply, and no way of building it to scale. Why? Well, we have not been trying very long or very hard. Our materials technologies are driven by information technology. Over the last century, science (which is being driven by technology, not the other way around) has been driven toward smaller, faster, more expensive materials.

Some say that to have large-scale materials you have to engineer them on the nanoscale and then fabricate them by the ton or the square kilometer. In fact, we do not have any large-scale materials technologies that conduct electricity other than wires. Metal, an ancient technology, is about the only thing we have.

It is a science problem but also an engineering one, because we have to develop new principles of design, new classes of materials. We have to find out how to self-organize on the nanoscale, and we have to push them very hard. And while that sounds like it is being driven by technology, I am absolutely certain that all kinds of unexpected science will come out of those drivers. (We could have an entire discussion about how science disciplines are, in fact, created in response to technology drivers, how, say, the technology driver of building better clocks led somebody to invent the mathematics which now produces semiconductors and lasers.)

At Argonne, the most fundamental of our programs is directed at gaining better control of our materials. We need to be able to engineer them precisely on the atomic scale, to design them in such a way that we know where each atom goes and what it will do.

Those of you who are not physicists might imagine that since we have had the Schrödinger equation, which controls all of this stuff, for nearly a century, we should know how to do this, but actually, we do not. Most of materials science is applied serendipity. We discover stuff, are amazed by it, and the science community chases it off into some corner to shine bright lights on it. Then some poor postdoc who has not discovered what the latest fashion is, digs around in some other part of the field and unearths something else that is important. We need to get much better than that.

The other thing we can do is focus on those areas of renewables where we can make gains in a short period of time. Electrical storage is an important part of a renewable portfolio because it is necessary for the

successful introduction of other technologies. You cannot have wind power unless you know what to do when the wind is not blowing. And you cannot have solar power unless you know what is going to happen when the sun goes behind a cloud.

The market in lithium batteries is already substantial – most people here today probably carry around two or three. Given this, we have a real opportunity, for example, to drastically reduce the consumption of imported fuel.

It is very difficult to make these changes in a developed country, however, because we have a strong fossil-based energy infrastructure and our economy is driven by short-term price concerns. The most rapid developments might well occur in the developing world, because they care more than we do. In Chicago, an electric car represents a modest choice based on cost and convenience.

But if you are in a village which is not on the power grid, and somebody gives you a set of linked technologies – solar photovoltaics, electrical storage, efficient refrigeration, and lighting – that means an enormous change. It means you have food storage, so you do not need to walk to the market every day; it means you have vaccinations and healthcare; and it means you have education. This is where we need to focus, because these are the changes that will actually change the world.

That also means that the economic transformation – and I am confident it will take place – is going to follow a certain geographical and social line. The ramifications of that are very difficult to predict. But as it is done in the past, so it will do in the future. We need to pay as much attention to the hidden benefits of what we are trying to do as we pay to the obvious ones.

Robert Rosner

Robert Rosner is William E. Wrather Distinguished Service Professor in Astronomy and Astrophysics and in Physics at the University of Chicago, and currently serves as one of the founding codirectors of the Energy Policy Institute at Chicago, as well as director of the Center for Exascale Simulations of Advanced Reactors. He was elected a Fellow of the American Academy of Arts and Sciences in 2001 and serves as Senior Advisor to the Academy's Global Nuclear Future Initiative.

When I first came back to the university from Argonne, I was very curious about how energy technologies, which Argonne is heavily involved in, enter into the real world and affect our lives.

I had a chance to speak with a number of folks from industry, and what I kept hearing was not that they were particularly interested in the latest scientific advances but that they were particularly interested in the issue of policy. That is, how does one actually take energy technologies that are developed in a laboratory, bring them through the development cycle, including the engineering, and then actually commercialize them in the context of a regulatory environment. Because in the end, if you do not commercialize energy technologies, you have not done anything – at least not from the point of view of the energy we want to use.

Materials scientists, I keep discovering, have lots to say about this topic. Richard Smalley invented the buckyball and carbon nanostructures, and after he won his Nobel Prize he turned to energy. He made a list of what he called the top ten problems of humanity. At the top of the list is energy, and all of the items he listed are interrelated, but if we have energy available and can deploy it, then we have one of the necessary tools to do something about the other issues.

So, given the fact that we live in a highly polarized political climate, what does it mean to formulate energy *policy*? What does it mean to implement energy policy? And what do we really mean by the word policy in the present political climate?

What is our energy policy? If I were to go to the library or Google, would I actually find a document that spells out U.S. energy policy (in the way that phrase is understood elsewhere in the world) or that describes what the government is doing in a coordinated way across a broad range of activities? You will be disappointed to learn that there is no such document. Nor is there such a document for industrial policy or, for that matter, environmental policy. These documents do not exist.

We do not broadly coordinate our efforts in science and technology. However, just because we do not have a document that says "this is our policy" does not mean there is not a policy. Policies often exist simply as a de facto set of things that we do.

It is useful to think a bit about what happened in the past. In the late 1700s, early 1800s, there was a real revolution in how we lived, namely the Industrial Revolution, and the original power source for this revolution was not fossil; it was water. The very first industrial locations, in the United King-

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dom, in the United States, and in continental Europe, were near rapidly flowing water.

But coal did make its presence felt quite early on, and the coupling of coal and industrial development was key to what happened both in Europe and in the United States. As measured by world per capita GDP, the wealth created as a consequence of the Industrial Revolution has been dramatic.

Coupled to that revolution are some unpleasant facts. One has to do with the introduction of carbon dioxide into the atmosphere. Rising levels of wealth and CO_2 have been coupled, and they are both the consequence of the Industrial Revolution. To what extent can we reconcile this?

In the United States, one usually does not discuss industrial policy, energy policy, or environmental policy as a coupled system of policy issues. Not so elsewhere. In Europe, for example, energy policy is often subsumed under the more general category of industrial policy, and environmental policy is usually thought of as a kind of constraint on what can be done.

In the United States, it is widely acknowledged that our energy security, our national security, and our economic security depend on having an innovative and agile manufacturing capability. And *that* depends on having access to energy.

But we also have a perspective, especially prominent during the election season, that government should not pick winners or losers, that the market decides. This is confounding. We recognize the importance of certain things but say government should not intrude too much. But to what extent do these two imperatives actually interact? Are they consistent with one another, and have we applied them consistently?

In the eighteenth century, the federal government was involved in building canals on the East Coast. In the nineteenth century, the federal government was very heavily involved in the First Transcontinental Railroad. The federal government was centrally involved during the 1920s and 1930s in building dams and expanding the electric grid as part of the Rural Electrification Program. Finally, the federal government was instrumental in building out the road system in the United States, an initiative that was pushed by President Eisenhower.

I think it is fair to say that in all of these cases an industrial policy element motivated federal action, a notion that the United States was a manufacturing country that depended on exports, ready access to raw materials, and efficient transport, as well as energy. The idea was to make sure we remained economically competitive on the international level. And that was seen as a function of the federal government.

Today we could say that the federal program that supports, for example, the aircraft industry, through orders for fighter planes, is instrumental in furthering the industrial competitiveness of the civil aviation sector in the United States. To illustrate, many of the technologies in Boeing's new Dreamliner aircraft – for example, fly-by-wire or the carbon fiber fuselage – were developed in the military context. When it comes to the competition between Airbus and Boeing, the Europeans like to remind us that we are heavily subsidizing Boeing's commercial side through our weapons programs.

This example is not at all isolated: in case after case, the federal government intentionally intervenes in support of U.S. industry. Where does this leave us?

Energy costs in the United States today are remarkably low by international standards. For example, the price of natural gas is somewhere between $3.00 and $4.00 per million BTU. In Asia, it is $15.00 – $20.00 for the same amount of gas. In Europe, it tends to be above $10.00 per million BTU.

So, from the point of view of energy supplies, we are extremely well positioned. But if we look at, for example, coupling what we do in the energy field with environmental issues, we know that this has been an area not just of struggle but, some people would argue, of abject failure over the past few years.

One typically sees controversy where economic interests collide. Think of the recent debates over subsidies for renewables. (Subsidies for oil and nuclear have been commonplace for thirty to forty years.) Think of the debates between rail transport and road transport. (Are these debates ever informed by consideration of which mode is, in fact, more efficient?) Think about the debates about high-speed rail versus aircraft transport for short distances, say, Chicago to St. Louis or Chicago to Detroit.

These questions are not debated on the basis of economic efficiency. They are based on other issues, typically ones having to do with competition between economic interests.

To what extent do we think about costs – especially life cycle costs – as determinative

for what energy technologies we use? Well, it is awfully hard to figure out actual costs when they are concealed by various kinds of subsidies, the regulatory environment, and so on. Knowing which of several options is the best choice is often very difficult as a practical matter.

So, woe is us. But have other people figured these things out, and if so, could we learn from them? Well, we know that energy policy in Europe and Japan is usually understood as part of a larger picture of industrial policy. In France, Germany, the United Kingdom, and Japan the imperative is on maintaining their international position as places that make stuff and export stuff, and most creation is tied to exporting things that are made in country.

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Their energy policy is thus an integral part of making sure that this, in fact, occurs. In particular, they recognize the importance of having the energy sources that are used for manufacturing to be dependable. This is coupled with maintaining the capability to actually do the manufacturing; for example, making sure that the workforce is maintained at a level where it can actually make stuff. Environmental policy has been viewed mostly as a complicating factor, mainly because, in places such as Germany, it has significantly raised energy costs.

In the United States, these issues rarely rise into the public forum.

What France, Germany, Japan, and the United Kingdom export the most of is stuff to which a huge amount of value has been added. Whether cars, optics, or pharmaceuticals, these are items requiring a talented workforce and high technology. Some of them also tend to be energy-intensive industries.

The key difference, I think, is that the role of government is viewed very differently in these countries, compared to the United States. Europeans, especially those on the continent, tend to reject the view, current in the United States, that national industrial policy is inconsistent with the currently ascendant economic theory. In Europe the government is usually not viewed as the enemy, and they reject the claim that industrial policy necessarily means that government is choosing winners. Why would government choose losers?

However, the conundrum in Europe is how to do all of these things, how to maintain economic competitiveness of the kind they are interested in while also maintaining an environmentally benign society. Germany is probably the poster child for this problem.

Germany faces enormous internal conflict about the use of nuclear energy. By and large, one finds consensus regarding environmental issues, but that consensus varies across the geography of Europe. The differences in labor costs in Western and Eastern Europe turn out to correlate with differences in views about environmental issues.

This has meant a huge incentive for German car manufacturers, for example, to move their manufacturing eastward. But for Germany that is an enormous problem from the perspective of maintaining a healthy labor market in the country. How this issue of Western Europe and Eastern Europe will play out remains to be seen.

Germany and the United Kingdom have very similar CO_2 emission profiles, as do France and Sweden. (The United States, because of our high energy intensity, is in a class of its own.) The reason France and Sweden have such relatively low emissions levels is that they are heavily dependent on nuclear power. Sweden produces roughly 50 percent of its electricity through nuclear, and the balance is largely produced through hydro. In fact, Sweden's CO_2 production is largely due to its transport sector.

France is in a similar position. They are about 80 percent nuclear, and they have a strong hydro component. They produce some fossil fuel-based electricity, but not much. Most of their CO_2 production again has to do with the transport sector.

What is striking about the temporal evolution of emissions profiles of France, Germany, Sweden, the United Kingdom, and the United States is that they are all heading in the same direction. In the case of the United States, I cannot point to specific national policies that account for the reduction. (I am dubious that the U.S. EPA CAFE mileage standards for vehicles can account for much of this reduction.) In the case of Germany, the downward slope is the result of quite intentional public policy moves by the German federal government.

What this seems to say is that it may well be possible that it hardly matters whether you have a policy because the end result may well be driven by other factors. We just have to figure out what those factors are.

This is an important point because in the developing world, the leading indus-

In the developing world, the leading industrial countries – China, India, Brazil – are well on their way to dominating worldwide CO_2 input to the atmosphere. Thus, their actions will largely determine what will happen to climate over the next fifty or so years.

trial countries – China, India, Brazil – are well on their way to dominating worldwide CO_2 input to the atmosphere. Thus, their actions will largely determine what will happen to climate over the next fifty or so years. We may think we provide the exemplars of what to do, but these countries will be determinative.

Each of these countries has an energy policy, and if you ask them what drives their policy you find that their concerns are totally different from what they might be in the United States, and certainly in Europe.

A couple of years ago at a conference, José Goldemberg, who was then the energy minister for the state of São Paolo, said he found the American participants' "woe is us" talk about climate to be interesting but completely irrelevant to Brazil. The number one issue for Brazilians was standard of living, not the climate. I think the same can probably be said for China and India.

Thus, the motivations felt in the developing world are likely drastically different from what motivates us, and it is not so obvious how what we do, our policies, and what we say to them can influence their behavior.

This brings me to my final point. I think it is fair to say that one of the reasons we in the United States have these polarizing debates about, for example, climate – debates that have not really made their presence felt in Europe – is because the idea of the social contract is felt here only periodically, and this is one of the periods when we don't have one.

One of the consequences of this is that a large fraction of our population really does not see our government as a protector of health and security and as a promoter of industry and wealth creation. Many would like to have the government move out of these realms. This leaves us an outlier not only among the industrial nations but in comparison to the developing world as well.

We don't have an obvious path for reconciling our political conflicts, and because of that our conflicts are going to be enormously constraining on our ability to move our economy forward in an efficient way. The real question, then, is how one rebuilds the social contract in the United States that allows us to heal the kinds of political divisions that are now blocking progress on reconciling our energy needs and our needs for job creation with environmental stewardship.

Historians tell us it has been like this before. U.S. history is full of periods of enormous social conflict and the sorts of disparities between political parties that we are seeing today. What history teaches us is that returning to a political climate that is a bit friendlier takes time. And, although we are a very impatient people, maybe the best counsel is to just be patient. ■

To view or listen to the presentations, visit http://www.amacad.org/events/energyfuturechicago/.

As of press time, several Fellows of the Academy, listed below, had been nominated or appointed to key positions in the Obama administration:

Hyman Bass (University of Michigan) was appointed Member of the President's Committee on the National Medal of Science.

Joseph S. Francisco (Purdue University) was appointed Member of the President's Committee on the National Medal of Science.

Ernest Moniz (Massachusetts Institute of Technology) was confirmed as the 13th U.S. Secretary of Energy.

Penny Pritzker (PSP Capital Partners and Pritzker Realty Group) was nominated as U.S. Secretary of Commerce.

Select Prizes and Awards to Members

John Simon Guggenheim Memorial Foundation Fellows, 2013

Elizabeth S. Anderson (University of Michigan)

Philip Bohlman (University of Chicago)

Lee Epstein (University of Southern California)

Lynn Garafola (Barnard College)

Scott Page (University of Michigan)

Ann Taves (University of California, Santa Barbara)

Other Awards

Alan Alda (New York, New York) received the 2013 Common Wealth Award for Dramatic Arts.

Christopher Benfey (Mount Holyoke College) received the 2013 Harold D. Vursell Memorial Award from the American Academy of Arts and Letters.

Bonnie Berger (Massachusetts Institute of Technology) received an Alumni Achievement Award from Brandeis University.

Eli Broad (Eli and Edythe Broad Foundation) and Edythe Broad (Eli and Edythe Broad Foundation) are the 2013 recipients of the William E. Simon Prize for Philanthropic Leadership, given by the Philanthropy Roundtable.

Angus Burgin (Johns Hopkins University; Visiting Scholar, 2009–2010) is the recipient of the 2013 Merle Curti Award, given by the Organization of American Historians.

Pierre Deligne (Institute for Advanced Study) was awarded the 2013 Abel Prize by the Norwegian Academy of Science and Letters.

Edward Feigenbaum (Stanford University) received the IEEE Computer Society's 2013 Computer Pioneer Award.

Shafi Goldwasser (Massachusetts Institute of Technology; Weizmann Institute of Science) is the recipient of the 2012 ACM A.M. Turing Award. She shares the prize with Silvio Micali (Massachusetts Institute of Technology).

Vartan Gregorian (Carnegie Corporation of New York) received the 2013 Distinguished Service Award from the Council on Foundations.

Nick Holonyak, Jr. (University of Illinois at Urbana-Champaign) has been elected a charter Fellow of the National Academy of Inventors.

Toyo Ito (Toyo Ito & Associates, Architects) is the recipient of the 2013 Pritzker Architecture Prize.

Deborah Jin (National Institute of Standards & Technology) is the 2013 North American Laureate of the L'Oreal-UNESCO Award in the Physical Sciences.

Robert Kraft (The Kraft Group) received the Carnegie Hall Medal of Excellence for Outstanding Leadership in Business and Philanthropy.

Neal Lane (Rice University) is the 2013 recipient of the Vannevar Bush Award, given by the National Science Board.

David McCullough (West Tisbury, Massachusetts) received the 2013 Common Wealth Award for Literature.

Silvio Micali (Massachusetts Institute of Technology) is the recipient of the 2012 ACM A.M. Turing Award. He shares the prize with Shafi Goldwasser (Massachusetts Institute of Technology; Weizmann Institute of Science).

J. Anthony Movshon (New York University) is the recipient of the 2013 Karl Spencer Lashley Award, given by the American Philosophical Society.

Jeremy Nathans (Johns Hopkins University School of Medicine) has been named a Gilman Scholar at Johns Hopkins University.

Bruno Nettl (University of Illinois at Urbana-Champaign) was awarded the Charles Homer Haskin Prize by the American Council of Learned Societies.

Sharon Olds (New York University) was awarded the 2013 Pulitzer Prize for Poetry.

Laurie Olin (Olin Partnership) was awarded the 2013 Thomas Jefferson Foundation Medal in Architecture.

Eric Olson (University of Texas Southwestern Medical Center) was awarded the 2013 March of Dimes Prize in Developmental Biology.

Svante Pääbo (Max-Planck-Institut für evolutionäre Anthropologie) was awarded the 2013 Gruber Genetics Prize.

James Salter (Bridgehampton, New York) is among the recipients of the Windham Campbell Prize, given by the Beinecke Rare Book and Manuscript Library at Yale University.

Eric Selker (University of Oregon) was named the 2013 Outstanding Scientist of the Oregon Academy of Science.

Joan Steitz (Yale University) is the recipient of the 2013 EMD Millipore Alice C. Evans Award, given by the American Society for Microbiology.

Eva Tardos (Cornell University) is among the recipients of the 2013 Technical Achievement Awards given by the IEEE Computer Society.

Susan Wessler (University of California, Riverside) has been named a Fellow of the American Society of Plant Biologists.

Robert J. Zimmer (University of Chicago) received an Alumni Achievement Award from Brandeis University.

New Appointments

Frances H. Arnold (California Institute of Technology) has been appointed to the Scientific Advisory Board of Genomatica.

Mary Cunningham Boyce (Massachusetts Institute of Technology) has been appointed Dean of the Fu Foundation School of Engineering and Applied Science at Columbia University.

Edward Kolb (University of Chicago) has been appointed Dean of the Physical Sciences Division at the University of Chicago.

Stephen M. Kosslyn (Stanford University) has been appointed the Founding Dean of the University of the Minerva Project.

Reynold Levy (Lincoln Center for the Performing Arts) has been elected to the Board of Directors of First Republic Bank.

Marcia McNutt (U.S. Geological Survey) has been named Editor-in-Chief of *Science*.

Richard Murnane (Harvard University) has been appointed Acting Dean of the Graduate School of Education at Harvard University.

David W. Oxtoby (Pomona College) has been elected President of the Harvard University Board of Overseers.

Judith Shapiro (Barnard College) has been named President of the Teagle Foundation.

Anne-Marie Slaughter (Princeton University) has been named President of the New America Foundation.

Katepalli R. Sreenivasan (New York University) has been appointed President of the Polytechnic Institute of New York University.

Patty Stonesifer (Bill & Melinda Gates Foundation) was named President and Chief Executive Officer of Martha's Table.

Thomas J. Sugrue (University of Pennsylvania) has been elected President of the Urban History Association.

Select Publications

Poetry

Carl Phillips (Washington University in St. Louis). *Silverchest*. Farrar, Straus & Giroux, April 2013

Robert Pinsky (Boston University) and David Lehman (New School University), eds. *The Best of the Best American Poetry*. Scribner, April 2013

Charles Simic (University of New Hampshire). *New and Selected Poems, 1962 – 2012*. Houghton Mifflin Harcourt, March 2013

Fiction

Anne Carson (McGill University). *Red Doc>*. Knopf, March 2013

Sidney Poitier (Los Angeles, California). *Montaro Caine*. Spiegel & Grau, May 2013

Nonfiction

Svetlana Alpers (New York University). *Roof Life*. Yale University Press, August 2013

Jagdish Bhagwati (Columbia University) and Arvind Panagariya (Columbia University). *Why Growth Matters: How Economic Growth in India Reduced Poverty and the Lessons for Other Developing Countries*. PublicAffairs, April 2013

David Blight (Yale University), Robert Harms (Yale University), and Bernard K. Freamon (Seton Hall Law School), eds. *Indian Ocean Slavery in the Age of Abolition*. Yale University Press, December 2013

Alan S. Blinder (Princeton University), **Andrew W. Lo** (AlphaSimplex, LLC; Massachusetts Institute of Technology), and **Robert M. Solow** (Massachusetts Institute of Technology), eds. *Rethinking the Financial Crisis*. Russell Sage, December 2012

Jonathan Brown (New York University) and Luisa Elena Alcala (Universidad Autónoma of Madrid). *Painting in Latin America, 1550 – 1820: From Conquest to Independence*. Yale University Press, October 2013

T. J. Clark (University of California, Berkeley). *Picasso and Truth: From Cubism to "Guernica."* Princeton University Press, June 2013

J. M. Coetzee (University of Adelaide, Australia) and Herman Parret (Leuven University, Belgium). *Cripplewood: Berlinde De Bruyckere at the Biennale di Venezia*. Yale University Press, October 2013

Dawn Coleman (University of Tennessee; Visiting Scholar, 2009 – 2010). *Preaching and the Rise of the American Novel*. Ohio State University Press, January 2013

Daniel C. Dennett (Tufts University). *Intuition Pumps and Other Tools for Thinking*. Norton, May 2013

Russell F. Doolittle (University of California, San Diego). *The Evolution of Vertebrate Blood Clotting*. University Science Books, August 2012

Richard B. Freeman (Harvard University), Joseph R. Blasi (Rutgers University School of Management and Labor Relations), and Douglas L. Kruse (Rutgers University School of Management and Labor Relations). *The Citizen's Share: Putting Ownership Back into Democracy*. Yale University Press, November 2013

Jack Fuller (Tribune Publishing Co.), ed. *Restoring Justice: The Speeches of Attorney General Edward H. Levi*. University of Chicago Press, May 2013

Howard Gardner (Harvard University) and Katie Davis (University of Washington). *The App Generation: How Today's Youth Navigate Identity, Intimacy, and Imagination in a Digital World*. Yale University Press, October 2013

Al Gore (Generation Investment Management U.S. LLP). *The Future: Six Drivers of Global Change*. Random House, January 2013

Kurt J. Isselbacher (Massachusetts General Hospital; Harvard Medical School). *Don't Call Me Cookie: A Memoir*. Ricbac Books, July 2012

Jerome Kagan (Harvard University). *The Human Spark: The Science of Human Development*. Basic Books, June 2013

Richard C. Levin (Yale University). *The Worth of the University*. Yale University Press, May 2013

Herbert Lindenberger (Stanford University). *One Family's Shoah: Victimization, Resistance, Survival in Nazi Europe*. Palgrave Macmillan, July 2013

Andrew W. Lo (AlphaSimplex, LLC; Massachusetts Institute of Technology), **Alan S. Blinder** (Princeton University), and **Robert M. Solow** (Massachusetts Institute of Technology), eds. *Rethinking the Financial Crisis*. Russell Sage, December 2012

Victor S. Navasky (*The Nation*; Columbia University Graduate School of Journalism). *The Art of Controversy: Political Cartoons and their Enduring Power*. Knopf, April 2013

William Nordhaus (Yale University). *The Climate Casino: Risk, Uncertainty, and Economics for a Warming World*. Yale University Press, October 2013

Joseph S. Nye, Jr. (Harvard Kennedy School). *Presidential Leadership and the Creation of the American Era*. Princeton University Press, June 2013

Robert M. Solow (Massachusetts Institute of Technology), **Alan S. Blinder** (Princeton University), and **Andrew W. Lo** (AlphaSimplex, LLC; Massachusetts Institute of Technology), eds. *Rethinking the Financial Crisis*. Russell Sage, December 2012

Billie Tsien (Tod Williams Billie Tsien Architects, LLP) and **Tod Williams** (Tod Williams Billie Tsien Architects, LLP). *Wunderkammer*. Yale University Press, November 2013

Brian Vickers (University of London), Gilles Monsarrat (Université de Dijon), and R. J. C. Watt (University of Dundee), eds. *The Collected Works of John Ford*, volume 1. Oxford University Press, December 2011

Rowan Williams (University of Cambridge). *Choose Life: Christmas and Easter Sermons in Canterbury Cathedral*. Bloomsbury Academic, May 2013

Tod Williams (Tod Williams Billie Tsien Architects, LLP) and **Billie Tsien** (Tod Williams Billie Tsien Architects, LLP). *Wunderkammer*. Yale University Press, November 2013

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. ■

Remembrance

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

Chinua Achebe – March 21, 2013; elected to the Academy in 2002

Paul Joel Alpers – May 19, 2013; elected to the Academy in 1996

Robert Lyle Bishop – February 7, 2013; elected to the Academy in 1958

George Edward Pelham Box – March 28, 2013; elected to the Academy in 1974

Donald Lyman Burkholder – April 14, 2013; elected to the Academy in 1992

Francis Hettinger Clauser – March 3, 2013; elected to the Academy in 1959

William Wallace Cleland – March 6, 2013; elected to the Academy in 1977

Christian René de Duve – May 4, 2013; elected to the Academy in 1971

Joseph Frank – February 27, 2013; elected to the Academy in 1969

Emil Frei III – April 30, 2013; elected to the Academy in 1999

Donald Glaser – February 28, 2013; elected to the Academy in 2003

John J. Gumperz – March 29, 2013; elected to the Academy in 1991

Robert Lee Hill – November 29, 2012; elected to the Academy in 1974

Robin M. Hochstrasser – February 27, 2013; elected to the Academy in 1982

François Jacob – April 19, 2013; elected to the Academy in 1964

Hilary Koprowski – April 11, 2013; elected to the Academy in 1974

Anthony Lewis – March 25, 2013; elected to the Academy in 1991

Tony Maxworthy – March 8, 2013; elected to the Academy in 2001

Ian Munro Ross – March 10, 2013; elected to the Academy in 1981

Francis Hugh Ruddle – March 10, 2013; elected to the Academy in 1977

Mary Ellen Rudin – March 18, 2013; elected to the Academy in 1991

Janos Starker – April 28, 2013; elected to the Academy in 1999

Karl Karekin Turekian – March 15, 2013; elected to the Academy in 1992

Kenneth Neal Waltz – May 12, 2013; elected to the Academy in 1980

Calvert Ward Watkins – March 20, 2013; elected to the Academy in 1973

Klaus Wyrtki – February 5, 2012; elected to the Academy in 2007

**Notice received from February 27, 2013 to May 31, 2013*

AMERICAN ACADEMY
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PHOTO CREDITS

Imijination Photography	pages 2 – 3, 10 – 11
Martha Stewart	pages 5 – 6, 18 – 19, 22
Wendy Barrows Photography	pages 12 – 13
Rod Searcey	pages 14 – 15
Alan Decker Photography	pages 27 – 28
Eric Craig Studios	pages 35, 38

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