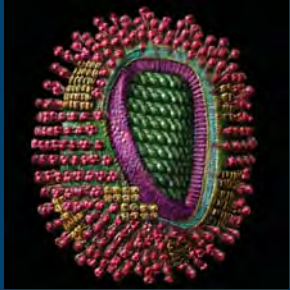




SUMMER 2006

Bulletin

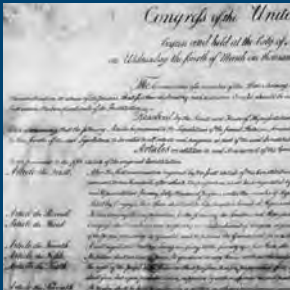
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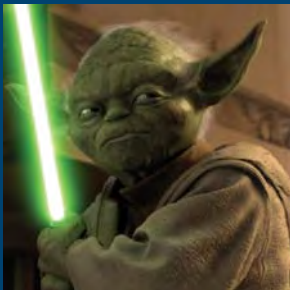
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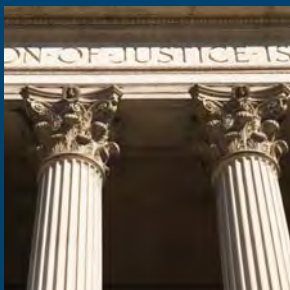
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AMERICAN ACADEMY OF ARTS & SCIENCES
Norton's Woods
136 Irving Street
Cambridge, MA 02138-1996 USA

telephone 617-576-5000
facsimile 617-576-5050
email aaas@amacad.org
website www.amacad.org





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AMERICAN ACADEMY
OF ARTS & SCIENCES

Thursday, September 7, 2006

Meeting – New York

Cohosted by New York University's John Brademas Center for the Study of Congress

The Broken Branch: How Congress is Failing America and How to Get It Back on Track

Speakers: Norman Ornstein, American Enterprise Institute, and Thomas Mann, Brookings Institution

Location: Kimmel Center for University Life, New York University

Time: 4:00 p.m.

Saturday, October 7, 2006

Stated Meeting and Induction Ceremony – Cambridge

Location: Sanders Theatre, Harvard University

Time: 3:30 p.m.

Monday, October 30, 2006

Meeting – Cambridge

Our Undemocratic Constitution: Where the U.S. Constitution Goes Wrong (and How We the People Can Correct It)

Speaker: Sanford Levinson, University of Texas at Austin

Respondents: Robert C. Post, Yale University, and Barney Frank, U.S. House of Representatives

Location: House of the Academy

Time: 6:00 p.m.

Wednesday, November 8, 2006

Stated Meeting – Cambridge

Location: House of the Academy

Saturday, November 11, 2006

Stated Meeting – Chicago

War and Peace in the Operas of Giuseppe Verdi

Speaker: Philip Gossett, University of Chicago

Location: Gleacher Center, University of Chicago

Time: 5:30 p.m.

Thursday, December 7, 2006

Meeting – New York City

The Future of News

Speakers: Ann Moore, Time, Inc.; Norman Pearlstine, Time Warner; John Carroll, Joan Shorenstein Center on the Press, Politics & Public Policy, Harvard University; Geneva Overholser, University of Missouri School of Journalism; Jeff Jarvis, BuzzMachine.com and CUNY; and Jill Abramson, *New York Times*

Location: Time-Life Building

Time: 5:30 p.m.

Wednesday, December 13, 2006

Stated Meeting – Cambridge

Speaker: Ellen T. Harris, MIT

Location: House of the Academy

For information and reservations, contact the Events Office (phone: 617-576-5032; email: mevents@amacad.org).

Academy News

New Officers and Councilor

The results of the spring ballot for the election of Officers, Councilors, and Members of the Membership Committee have been tabulated. Brief biographies of the new Officers and Councilor are printed below. We thank the Fellows who participated in the election process. The positions open in 2007 are listed on page 4.



Emilio Bizzi

President

Emilio Bizzi, a leading brain scientist and Institute Professor at the Massachusetts Institute of Technology, has been elected to serve as the 44th President of the Academy. He will take office at the Induction Ceremony in Cambridge on October 7, 2006.

Born in Rome, Bizzi received his M.D. and Ph.D. (Docenza) from the University of Rome. He came to the United States in 1963 to conduct research at Washington University in St. Louis and at the National Institute of Mental Health. In 1969 he joined the MIT faculty where he has served as Director of the Whitaker College of Health Sciences, Technology, and Management (1983–1989) and as Chair of the Department of Brain and Cognitive Sciences (1986–1997).

Bizzi's early career work included a study of the neurophysiological mechanisms of sleep. Subsequently, he investigated the way

in which the central nervous system generates voluntary movement. His current research centers on understanding how motor skills are learned. Bizzi's laboratory has developed a theoretical and experimental framework to describe the way in which the central nervous system transforms planned movements into muscle activations. His work is of critical importance in the design of neuroprosthetics for amputees or individuals with motor disabilities. He has received several honors for his research and academic work, including the W. Alden Spencer Award, the Hermann von Helmholtz Award for Excellence in Neuroscience, and, in 2005, the President of Italy Gold Medal for achievements in science.

A member of the National Academy of Sciences, the Institute of Medicine, and the Italian National Academy (Accademia Nazionale dei Lincei), Bizzi was elected to the American Academy in 1980. He served as Secretary of the Academy from 1998–2005 and is a member of the Academy Trust. In 2004, he organized a joint meeting of the American Academy and the Lincei in Rome.

Vice President, Western Region

Gordon N. Gill, a physician and researcher, is the new Vice President of the Academy's Western Region. A member of the Academy for the past ten years, Gill has served as Chair of the membership section for medicine and public health and as Cochair of the Western Region.

Gill is Emeritus Professor of Medicine and of Cellular and Molecular Medicine at the University of California, San Diego. He received his B.A. and M.D. degrees from

Vanderbilt University. After serving a residency and a National Institute of Health postdoctoral fellowship at Yale-New Haven Hospital, he continued his NIH-sponsored research in metabolism and endocrinology at UCSD. During his tenure there, he served as Chief of the Division of Endocrinology and Metabolism, Chair of the Faculty of Basic Biomedical Sciences, Dean for Scientific Affairs, and interim Director of the Moores Comprehensive Cancer Center. He is presently Dean for Translational Medicine and Director of the College of Integrative Life Sciences. He has been a member of numerous scientific boards and of the editorial board of many professional journals.

Gill's laboratory studies hormone action and signal transduction, the molecular mechanisms through which information is received and translated into biological responses. As a key participant in the growth of medical research at UCSD with a commitment to improving graduate medical education, Gill has advocated efforts to strengthen the role of the physician-scientist and the active involvement of clinical investigators in biomedical research.

Councilor

Eric Sundquist, a leading scholar of American literature and culture and African American studies, has been elected to the Academy Council as a representative of Class IV: Humanities and Arts. A Fellow of the Academy since 1997, he is UCLA Foundation Professor of Literature and a member of the Department of English at the University of California, Los Angeles. He received his B.A. from the University of Kansas and his Ph.D. from Johns Hopkins University.

Sundquist is the author or editor of nine books including *Strangers in the Land: Blacks, Jews, Post-Holocaust America* (2005) and *To Wake the Nations: Race in the Making of American Literature* (1993), which received the James Russell Lowell Prize from the Modern Language Association for the best book published during the year and the Christian Gauss Award from Phi Beta Kappa for the best book in the humanities. Recognized for his breadth of knowledge of both American history and literature, his other works include *Home as Found: Authority and Genealogy in Nineteenth-Century American Literature* (1979), *Faulkner: the House Divided* (1983), and *The Hammers of Creation: Folk Culture in Modern African-American Fiction* (1992). His contribution to Volume 2 of the *Cambridge History of American Literature* (1995) has recently been reprinted as *Empire and Slavery in American Literature, 1820 – 1865* (2006). He has also edited essay collections and anthologies on American realism, Frederick Douglass, Mark Twain, W.E.B. DuBois, and Ralph Ellison. From 1991 – 1997, Sundquist was general editor of the Cambridge University Press series *Studies in American Literature and Culture*.

In addition to teaching at UCLA, he was Dean of the Weinberg College of Arts and Sciences at Northwestern University from 1997 – 2002.

Members of the Council include:

Robert Alberty (MIT)

Gerald Early (Washington University in St. Louis)

Carol Gluck (Columbia University)

Linda Greenhouse (*The New York Times*)

Charles M. Haar (Harvard University)

Jerome Kagan (Harvard University)

John Katzenellenbogen (University of Illinois at Urbana-Champaign)

Neal Lane (Rice University)

Richard Meserve (Carnegie Institution of Washington)

David D. Sabatini (NYU)

Randy Schekman (University of California, Berkeley)

Eric Sundquist (University of California, Los Angeles)

and the Officers of the Academy:

President **Patricia Meyer Spacks** (University of Virginia)

President-elect **Emilio Bizzi** (MIT)

Chief Executive Officer
Leslie C. Berlowitz

Vice President and Chair of the Academy Trust **Louis W. Cabot** (Cabot-Wellington LLC)

Treasurer **John Reed** (New York City)

Secretary **Jerrold Meinwald** (Cornell University)

Editor **Steven Marcus** (Columbia University)

Librarian **Robert C. Post** (Yale University)

Vice President, Western Region
Gordon N. Gill (University of California, San Diego)

Vice President, Midwest Region
Geoffrey Stone (University of Chicago)

New Membership Committee Chairs:

Edward A. Feigenbaum, I:6
Stanford University

Thomas W. Cline, II:2
University of California, Berkeley

Michael Gazzaniga, II:3
University of California, Santa Barbara

Jean D. Wilson, II:5
University of Texas
Southwestern Medical Center

Phoebe C. Ellsworth, III:1
University of Michigan

Alan Krueger, III:2
Princeton University

Kathleen M. Sullivan, III:4
Stanford University

Jane A. Bernstein, IV:5
Tufts University



Gordon N. Gill
Vice President, Western Region



Eric Sundquist
Councilor

University Affiliates

A growing group of colleges and universities throughout the country are collaborating with the Academy by participating in its studies on higher education and helping to support its Visiting Scholars Program. The Academy is grateful to these University Affiliates for their confidence in the Academy's efforts to support interdisciplinary research and to expand opportunities for postdoctoral scholars and junior faculty.

American University – Cornelius Kerwin, Interim President
Boston University – Robert A. Brown, President
Brandeis University – Jehuda Reinharz, President
Brown University – Ruth J. Simmons, President
The City University of New York – Matthew Goldstein, Chancellor
Columbia University – Lee C. Bollinger, President
Cornell University – David J. Skorton, President
Dartmouth College – James Wright, President
Duke University – Richard H. Brodhead, President
Emory University – James W. Wagner, President
George Washington University – Stephen J. Trachtenberg, President
Harvard University – Derek Bok, Interim President
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Northwestern University – Henry S. Bienen, President
Ohio State University – Karen A. Holbrook, President
Pennsylvania State University – Graham Spanier, President
Princeton University – Shirley Tilghman, President
Rice University – David W. Leebron, President
Rutgers, The State University of New Jersey –
Richard L. McCormick, President
Smith College – Carol T. Christ, President
Stanford University – John L. Hennessy, President
Syracuse University – Nancy Cantor, President and Chancellor
Tufts University – Lawrence S. Bacow, President
University of California, Berkeley – Robert J. Birgeneau, Chancellor
University of California, Davis – Larry N. Vanderhoef, Chancellor
University of California, Irvine – Michael V. Drake, Chancellor
University of California, Los Angeles – Norman Abrams, Acting Chancellor
University of California, San Diego – Marye Anne Fox, Chancellor
University of Chicago – Robert J. Zimmer, President
University of Illinois at Urbana-Champaign – Richard Herman, Chancellor
University of Iowa – Gary Fethke, Interim President
University of Maryland – C. D. Mote, Jr., President
University of Michigan – Mary Sue Coleman, President
University of Minnesota – Robert Bruininks, President
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University of Pennsylvania – Amy Gutmann, President
University of Pittsburgh – Mark A. Nordenberg, Chancellor
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University of Virginia – John T. Casteen III, President
University of Wisconsin-Madison – John D. Wiley, Chancellor
Virginia Polytechnic Institute and State University –
Charles W. Steger, President
Wellesley College – Diana Chapman Walsh, President
Yale University – Richard C. Levin, President

Visiting Scholars Program Postdoctoral and Junior Faculty Fellowships

2007–2008

Postmark Deadline: October 16, 2006

The American Academy of Arts and Sciences, an international learned society and research institute in Cambridge, Massachusetts, invites postdoctoral scholars and untenured junior faculty to apply for research fellowships for the 2007–2008 year.

The Academy is especially interested in proposals that relate to its current projects in the following areas: Humanities & Culture, Science & Global Security, Social Policy & American Institutions, and Education. For more information on these studies, please visit the Academy's website (www.amacad.org/projects.aspx). Projects that address American cultural, social, or political issues from the founding period to the present are eligible, as are studies that consider developments in public policy from a multidisciplinary and/or comparative perspective. Projects that relate to the history of the Academy, drawing on its historic holdings, and to the history of science and technology from the late eighteenth century to the present are encouraged.

Visiting Scholars are expected to participate in conferences, seminars, and events at the Academy while advancing their independent research; they must be in residence during their fellowship year.

Terms of Award: Up to \$35,000 stipend for postdoctoral scholars; up to \$50,000 for junior faculty (not to exceed one-half of salary).

For details, contact: The Visiting Scholars Program, American Academy of Arts and Sciences, 136 Irving Street, Cambridge, MA 02138-1996; phone: 617-576-5014; fax: 617-576-5050; email: vsp@amacad.org.

Application information is available on the Academy's website at www.amacad.org/visiting.aspx.

Fellows are asked to encourage students and colleagues to apply.

A Remembrance



Photo credit: John Earle

Jaroslav Jan Pelikan

Jaroslav Pelikan, who died May 23, 2006, was the kind of intellectual colleagues might call “a scholar’s scholar” or “an historian’s historian.” If such titles characteristically connote devotion to a specialty at the expense of awareness of or service to a larger world, they would be too confining for Pelikan.

Fellows of the American Academy of Arts and Sciences would be the first to attest to his administrative skills, his vision for institutional programs, his collegial spirit, and his devotion to his responsibilities. He served as the Academy’s President (1994 – 1997), having previously participated in numerous programs and served in various advisory capacities.

A familiar figure at Academy gatherings, he could cross disciplines with finesse and converse on an astonishing range of subjects. The Sterling Professor of History at Yale was capable of performing on the piano, and once shared a stage with cellist Yo-Yo Ma. While producing his book *Bach Among the Theologians*, he formed a close relationship with the late conductor Robert Shaw. A humanist, he took seriously the scientific enterprises in the Academy and impressed the Fellows with the generous ways he recognized their achievements and featured them in programs.

The Academy did not and could not have Professor Pelikan to itself. He was also President of the American Academy of Political and Social Sciences as well as president of several religious historical societies. He was the first Chairman of the Council of Scholars at the Library of Congress, where he was awarded the Kluge Prize in 2004, the “Nobel-level” award in the humanities. The National Endowment for the Humanities recognized his many contributions to the humanities by naming him the twelfth Jefferson Lecturer. He also delivered the Gifford Lectures on Christianity and Classical Culture at the University of Aberdeen in 1992 – 1993. He was Dean of graduate studies at Yale from 1973 – 1978, where he mentored many graduate students and excelled as an undergraduate lecturer.

A scholarly prodigy, he received his Ph.D. at the University of Chicago in 1946, when he was twenty-four years old – he’d been typing for twenty-one years by then – the same year he received the Bachelor of Divinity degree and married Sylvia Burica. She shared his interest in the humanities and was a familiar figure at Academy events.

That “many” regarded him the foremost historian of Christianity in the past half century, as some obituaries had it, is a safe generalization; it is hard to think of a peer. His *exemplum*, Adolf Harnack, with whom he had fundamental disagreements, would be the only challenger to his superior reputation. Pelikan’s main mark in that field was his magisterial five-volume *History of the Christian Tradition*.

Those who worked in fields similar to his were awed at the knowledge and equipment he brought to them. I have had sixty years to observe and reflect, all the way back to the time when the newlywed Martys in the 1950s babysat for the Pelikans. What dazzled me most, as it has astounded others, was his ability to read, speak, and write in many languages. For his role in editing twenty-two volumes of *Luther’s Works*, he handled late-medieval Latin and early-modern German as any scholar in that field would. For *History of the Christian Tradition*, he put his reading knowledge of more than ten languages to work.

Foreign Honorary Members of the Academy can testify to the ease with which he spoke their languages. My most vivid recall was of an occasion when we were being shuttled to the National Humanities Center in North Carolina. As we got off, I could not resist asking what language he’d been using to converse with a seatmate, a guest of the Center. “Oh, that was Albanian.” (This was when Albania was the most closed-off state behind the Iron Curtain.) How could he do that? This proud son-of-a-Serb said, “Oh, if you know one of those languages, you know them all.”

Though a popular writer, he did not court popularity, a fact that is evidenced by his choice of subject matter. Words like “Tradition,” “Orthodoxy,” “Dogma,” and “Doctrine” are hardly candidates for inclusion in titles of bestsellers. His works on *Jesus Through the Centuries* and *Mary Through the Centuries*, however, were very widely circulated and translated into numerous languages. Like few other scholars in his time, he straddled the zones often marked “secular” and “religious,” was at home in both, and fostered informed conversation among fellow scholars who had felt more at ease in only one of them. Fortunately, through his long career of teaching first at the University of Chicago and then at Yale, he nurtured and stimulated generations of scholars who continue to work in the fields he cultivated, so his influence will only grow.

Martin E. Marty
University of Chicago

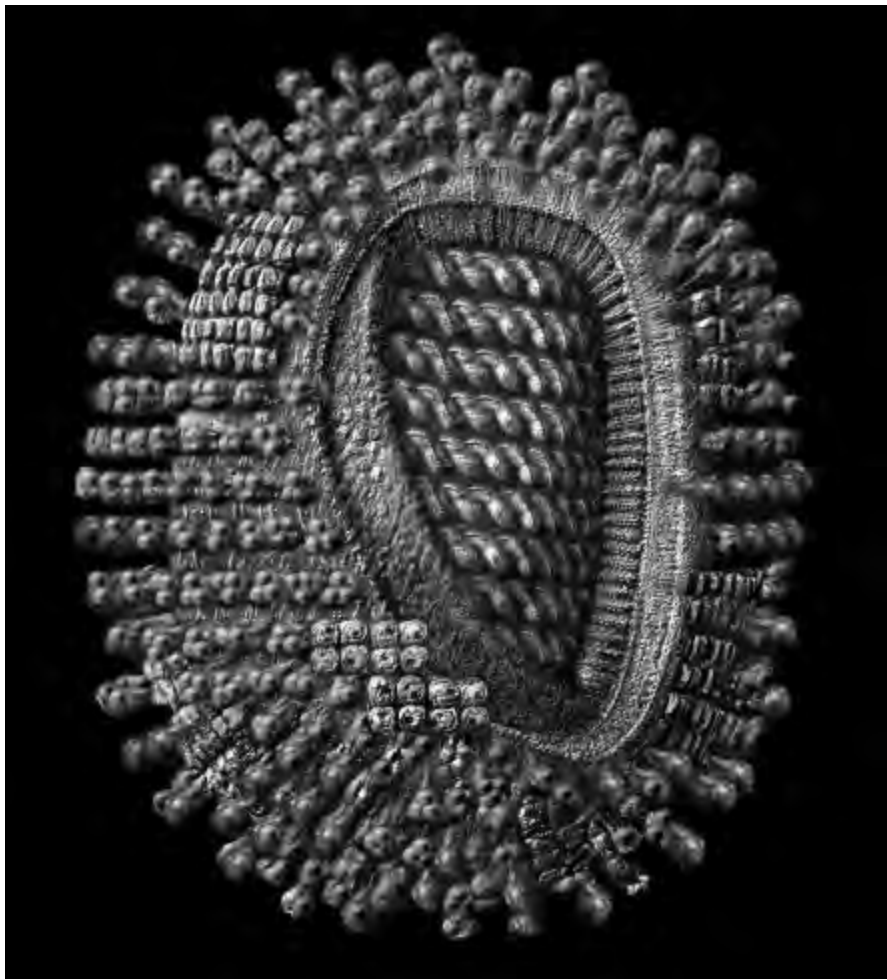


Illustration of an influenza virus partially cut away to reveal the internal structures. © Russell Kightley

Is Science Under Siege?

Harold Varmus

This is an updated and edited version of a presentation given at the 1895th Stated Meeting, held at Rockefeller University on November 16, 2005.

Harold Varmus is President of Memorial Sloan-Kettering Cancer Center. He has been a Fellow of the American Academy since 1988.

The cardinal attributes of science – discovery, innovation, rejection of dogma, exploration of frontiers – have been emblematic of our nation’s character from the outset. Many of those who founded our country thought of themselves as scientists. And when the American Academy was established in 1780, it chose to include the sciences in its title.

Science has thrived here, and we have become the nation most advanced in virtually all fields of science and technology. As a nation of immigrants, we have attracted bright people who studied and stayed here; even today,

one quarter of the members of the National Academy of Sciences were born abroad. American scientists have been central to the discoveries of the twentieth century that have transformed our understanding of the world, driven our economy, and radically altered and dramatically extended our lives – atoms and genes; new vaccines, medicines, and chemicals; airplanes, televisions, cell phones, lasers, computers, and pacemakers.

Midway through the twentieth century, after science helped us win the Second World War with quinine, radar, and atomic bombs, our federal government assumed responsibility for a massive expansion of research, especially basic research; the bargain may have had Faustian aspects, but the dividends have been handsome.

At the start of this new century, science continues to be exhilarating. In my own field of cancer research, these are extraordinary times. By learning the genetic damage that drives cells to become cancerous, we can classify cancers more accurately and, for a few important conditions, treat them more effectively. Memorial Sloan-Kettering Cancer Center is not alone in showing enthusiasm for science by expanding our research facilities, building new programs, and training more people to study these diseases.

From this perspective, it may seem surprising that we are gathered here tonight to worry about the scientific enterprise in America. But – despite the successes of the past century and despite the optimism about what science can achieve in the next – science seems to be under attack on several fronts. Scientists report anxiety about their career prospects and a sense of alienation from the dominant culture and politics of our society. Anxiety and alienation are not new to science, but they are perceived as more acute and more intense now than in recent memory and driven by many things: by an underappreciation of science as an essential feature of our culture, by declining budgets for science, and by sharpened conflicts with religion in education and science policy.

I have been asked to speak to you today about these anxieties – their causes, the objective reality, and some remedies. To do this, I must talk about topics on which I must confess not to be truly expert: political science, ethics, economics, history, and even theology. But I can give you a personal account of the concerns; I can try to categorize and analyze them as a working scientist perceives them; and I can make some judgments about their seriousness and reversibility.

Immediate targets of concern among scientists

At least four interwoven topics are prominent in conversations among scientists who are worried about the status of science in America today: the diminished role of science in the formulation of policy by the current administration; the actual policies that have been developed in the scientific arena; the diminishing resources for funding science and for the training of scientists; and the intrusion of religion into science policy and education.

Evidence that the current administration does not adequately incorporate scientific advice in the process of formulating its

Despite the successes of the past century and despite the optimism about what science can achieve in the next, science seems to be under attack on several fronts.

policies has been widely promulgated by the Union of Concerned Scientists since February 2004 (www.ucsusa.org/scientific_integrity/). Many experienced advisors for previous administrations, Democratic or Republican, argue that this shift away from a full review of the available facts has produced policies affecting many domains of governance that lack a strong evidentiary basis and run counter to the long-term interests of the country.

Consider the case of human embryonic stem cell research. For those of us – scientists and citizens alike – who are impressed with the prospects for discoveries and, ultimately, beneficial changes in medical practice through such research, the present rules that govern federal spending on embryonic stem cell research are troubling and unduly restrictive. They have slowed the pace of progress here, given advantage to other countries (such as the United Kingdom) with more enlightened policies, and discouraged young scientists from contemplating careers in this exciting new field.

The decision to limit federal funding of human embryonic stem cell research to cell lines derived before President Bush's speech on August 9, 2001, seemed politically calculated, rather than scientifically reasoned, even at the time. So some of the consequences have been predictable. For instance, the number of useful lines was never as large as claimed, has diminished with time, and never included lines that could be used in patients.

Other consequences would have been difficult to anticipate. The most important, in the long run, may be a fragmentation of the nation's research effort. Rather than build-

ing a unified national program to pursue this new work, we are creating a patchwork quilt of state policies that range from prohibitions of work permissible elsewhere to state financing of work ineligible for federal dollars. California illustrates the latter extreme: voters strongly endorsed stem cell research by passing a bond measure that will provide \$3 billion over ten years, if the multiple legal challenges to the initiative can be resolved. A few other places, including New York City, have benefited from private philanthropy for stem cell work. These pockets of affluence will inevitably and inequitably distort the distribution of stem cell investigators across the nation, and these precedents could provide incentives to further fragment the historically successful federal oversight and funding of medical research.

Such policy issues are important, but for most scientists in the trenches the most immediate and daily concern is financial support for their disciplines and the ability to attract bright trainees to work with them. The United States still leads the nations in total support for science, and it remains among the top few when science funding is measured as a fraction of the Gross National Product. But budget projections for science agencies are flat, without even inflationary increases, at a time when the promise of science and the need for science are unprecedented. Federal support for the physical sciences has been unchanged or declining for many years, with no improvements in sight. Funding for elementary particle physics, for example, has been in steady decline for several years, and leadership of a field that we once dominated is now at least shared with European physicists, who are hosting the Large Hadron Collider in Geneva, where the next major discoveries are likely to be made after it opens in 2007.

Even the NIH, with the biggest budget among the federal science agencies, about \$28 billion, is facing trouble. The Bush administration fulfilled its pledge to finish a five-year doubling of the budget that began in the Clinton era. But for the past two years – and almost certainly for the coming year as well – the NIH budget has been flat, without even an inflationary increase. With this progressive loss of purchasing power, fewer grants can be awarded at a time when the number of active investigators has grown significantly. This means that the success rates for grant applicants will be low, as low

as 10 to 20 percent, even for new applicants, such as those who have finally taken faculty positions after many years of undergraduate, graduate, and postdoctoral training. Such stiff competition produces poor or arbitrary decisions and demoralizes the frustrated applicants and reviewers alike. It should also worry the public that paid for much of the training of new investigators and wants them to be working in the laboratory, not rewriting grant applications.

Although many excellent students are training in the sciences in the United States at present, the budget forecasts transmit a discouraging message to prospective trainees. For several years American undergraduates have been steering away from math and some of the physical sciences. And, as has been widely publicized, foreign students who had taken their places have been applying to our graduate schools in smaller numbers for the past few years.

There is yet another widespread and profoundly troubling phenomenon affecting the climate for science in the country: the intrusion of religion into the domains of science. No one in this audience can be oblivious to the efforts by components of the religious right to undermine the teaching of evolution in high-school science classes. Indeed, hardly a day goes by without a prominent article in our leading newspapers about one of the battlegrounds or about the resurgence of creationism masquerading under the pretentious name of "intelligent design" (ID). For anyone who has not heard, proponents of ID try to discredit Darwinism by pointing to human eyes or bacterial flagella as examples of

For most scientists in the trenches the most immediate and daily concern is financial support for their disciplines and the ability to attract bright trainees to work with them.

"irreducible complexity" that evolution can't fully explain, implying they must be products of a supernatural force.

Those who defend the concept that religious ideas, such as ID, have no place in science classrooms took heart, at least briefly, after November's elections. In Dover, Pennsylvania, where efforts by the local school board

There is yet another widespread and profoundly troubling phenomenon affecting the climate for science in the country: the intrusion of religion into the domains of science.

to present ID in biology classes were challenged in the courts, voters replaced their entire school board with new members pledged to keep science separate from religion. Then, a month later, a federal judge issued a remarkably well-reasoned ruling that supported the contentions of the new board members (www.pamd.uscourts.gov/kitzmiller/kitzmiller_342.pdf).

But these battles are far from over. New standards that weaken the teaching of evolution have been approved (but not yet implemented) in Kansas; other efforts to undermine instruction in evolution, the governing principle for all of modern biology, are ongoing in many of our states; and polls by the Pew Trust indicate that as many as 38 percent of Americans would like to see creationism *replace* evolution, not just coexist with it, in the high-school curriculum.

Still, I have been encouraged by the excellent and frequent coverage of these developments in our leading newspapers and magazines; by the bold warnings by some of our university presidents, especially Shirley Tilghman of Princeton and Hunter Rawlings of Cornell; and by the actions of many scientists, religious leaders, and other citizens concerned about the erosion of First Amendment principles, who have joined organizations formed to defend those principles.

The underlying causes of current concerns

How do we account for the many troubling features of the landscape that I have just painted? In my view, there are at least three underlying causes of our woes: the uncertain and poorly guarded boundaries between religion and state; the failure to recognize science as a foundation of our social and economic well-being; and ambivalent attitudes toward the rest of the world.

Limiting the influence of religion. The boundaries between religion and state have become increasingly blurred over the past several years, to the point where the growing political force of evangelical Christians, often known as the "religious right," is affecting science (stem cell policy), the teaching of science (intelligent design), and public health (opposition to Plan B, the drug that can prevent unwanted pregnancies resulting from recent unprotected sex, and opposition to the use of condoms in HIV prevention strategies). In the category of public health, religious dogma is trumping life itself.

It is ironic that some in this country have become captive to a relatively narrow segment of the religious spectrum at a time when the breadth of that spectrum has grown dramatically, particularly with increasing immigration from Asian countries. But we as citizens have been lax in our responsibility to the First Amendment to ensure the separation of religion and state. And we as scientists have not been adequately engaged in efforts to understand and explain the relationship between religion and science.

Any first step in those efforts is to describe science and religion as largely separate spheres of activity: science asking *How*, religion asking *Why*; science invoking Reason, religion invoking Faith; science depending on objective evidence from the natural world, religion depending on subjective feelings and thoughts. Seen in this way, as many have noted, they are compatible and even complementary. Such distinctions help to explain why creationism (or ID) should not be mentioned in science classrooms: it makes no testable predictions and is supported by no evidence. It is not science.

But we also need to acknowledge that science and religion can be in conflict – and have been throughout history – depending on the sci-

entific realms and the religious precepts. Most areas of science do not confront religious teachings as directly as reproductive biology, evolutionary sciences, or cosmology can. And some religions are much less dogmatic and prescriptive than others.

Many who turn to religion for help are seeking some sense of purpose for the bad things that happen. But one of the dominant ideas that emerges from the scientific study of the cosmos, evolution, and reproduction is that of *chance*. For many scientists, chance happenings can seem as remarkable as a god's purposes. The idea that chance, over billions of years, could lead to our universe, our galaxy, our earth, life forms, the human species, and, especially, the human brain, is, in itself, breathtaking. Jacques Monod, one of the founders of molecular biology, said it well: "... like the man who has just won a million, we still feel the strangeness of our condition." A god may be an intruder on this landscape.

Just as science and religion need to define their differences, they also need to seek common ground. It is often said that scientists need to show more tolerance of religion. Yes, but religious groups, especially those in the fundamentalist sector, need to show more tolerance of secular humanism – a creed common among scientists. As recent

Just as science and religion need to define their differences, they also need to seek common ground.

reports in the *New York Times* indicate, some components of the religious right are collaborating with environmental activists to protect the earth against global warming, and others are working with public-health advocates for more spending to combat disease in Africa. The world needs more such collaborations.

Current worries about the possibilities of an impending epidemic of avian influenza, one as terrible as the epidemic of 1918, may offer another platform for an enlarged understanding. During his remarks about the influenza situation last fall, President Bush referred to the idea that "from time to time, changes in the influenza virus result in a

new strain to which people have never been exposed. These new strains have the potential to sweep the globe. . . .” This is pure Darwinism: natural variation and selection. The influenza virus (pictured at the start of this article) may look like a complex machine, with its spiked globe and multiple chains of nucleic acid, but no one is arguing that it or its derivatives are the “irreducibly complex” products of intelligent design. When the stakes are high, almost everyone turns to real science for help.

Recognizing the economic benefits of science. Scientists have largely themselves to blame for a second problem: we have failed to keep the public adequately apprised of the crucial links between science and the social and economic benefits enjoyed in the developed world. This failure has been especially damaging in the current administration, which has allowed our budget deficits to mount and our science budgets to fall. Because the investments in science and technology are crucial to the economic health of the nation, producing well-documented returns of 130 to 150 percent, the administration may prove to be less of a friend to American business than is commonly thought.

In the long run, our attitudes and policies threaten our future productivity and competitive stature. This message is central to a report recently issued by the National Academies, *Rising above the Gathering Storm* (www.nap.edu/books/0309100399/html). The report is critical of the low status accorded to science teachers in our elementary and high schools; of the erratic and largely declining investments we are making in basic science; and of our failure to recognize that industrial productivity depends on scientific proficiency and incentives for innovation. The authors – who are themselves captains of industry, presidents of universities, and prize-winning scientists – reflect the influence of Tom Friedman’s new book, *The Earth is Flat*, emphasizing the competitive challenge that we now face from India, China, and other Asian nations where students excel in science and math, where governments recognize that their futures depend on a highly skilled work force, and where high-technology businesses are growing rapidly.

In reading the report, I was reminded of an essay written several years ago by David Goodstein, a physicist at Caltech. Goodstein observed that we use the wrong metaphor to

describe how we teach science to children in the United States. We don’t have a pipeline that all students flow through, with a subset emerging as working scientists at the end. Instead, we have a diamond mine in which we prospect, even at very early stages, for the gems who can win Westinghouse (now Intel) Prizes and then go on to even greater glory after attending schools on scholarships. We have done well with this method, fostering innovation, making discoveries, winning Nobel Prizes, building great universities and industries, and accumulating national wealth. But at the same time we have ignored the need for that large pipeline of students with

We are now in danger of losing our position at the head of the global pack unless we make substantial investments to support the teaching and practice of science.

strong skills in computation and technology as well as knowledge of scientific principles. This is the method that also generates science-savvy citizens.

As the report explains, we are now in danger of losing our position at the head of the global pack unless we make substantial investments to support the teaching and practice of science. But this news comes at a time when we lack the financial resources to respond to the report’s expensive recommendations with anything other than a resigned shrug.

Reestablishing beneficent internationalism. America’s status in the world has changed. We are now a feared and unequalled military power, neither faced off against the Soviets nor joined in harmonious alliances. In the eyes of many peoples around the world, we have become both a despised invader and a vulnerable target for terrorism, not the benevolent promoter of democracy we may aspire to be. And, while we remain the world’s industrial leader, we are now being challenged by rising productivity in Asia and a united Europe.

We cannot afford to respond to these conditions with xenophobia or isolationism. Initially, after 9/11, immigration procedures became tougher, even for students and visiting scientists. Although the U.S. Immigration and Naturalization Service has responded to complaints from the academic community and eased visa procurement, impressions are hard to erase. While the declines in applications from abroad are not large, they are indisputable and worrisome: students, especially from Asia, are shifting their sights, mainly to other English-speaking countries with strong science programs.

This is a loss for us and a change in international reputation that we must work to restore. We may have squandered the sympathetic goodwill that we enjoyed after 9/11. But, at only modest cost, we can use our scientific skills to reestablish our good character. There are many ways to do this – by helping to coordinate international surveillance against infectious diseases, like influenza, SARS, and HIV; by increasing our investments in science done abroad, especially in poor countries and especially on topics that promise local benefit (medicine, agriculture, energy production, and environmental remediation); by promoting connectivity through the Internet and assuring that scientific reports are made readily accessible to all. The essential internationalism of science is a powerful force that we can and should harness: to defend against global epidemic diseases, to diminish threats to the world’s climate and environment, and to improve the well-being of people who live in the developing world, while also reversing our declining reputation.

Is science under siege?

So how should we answer my rhetorical title? Is science under siege? I am sorry to say: Yes and No. “Siege” is probably too strong. “Stress” or “duress” might be more appropriate words, although they might have attracted a smaller audience. And, of course, science has always been under suspicion or even attack from various quarters, sometimes even from liberal academics. So how do we judge our current position?

First, it is important to acknowledge our continued strengths. There is still considerable federal financing of science, and, unlike scientific institutions in most other coun-

tries, our academic institutions enjoy additional financing from industry and from philanthropy. The science done here is still outstanding, and the United States remains the leader in most areas. In general, the public has confidence in science and scientists, especially in moments of crisis, even though large parts of it are ill-informed about science and misguided about how we should teach it. No significant exodus of our scientists has occurred, and we continue to attract many excellent students from abroad.

But it is equally important to recognize other troubling features of the landscape: the fragility of the scientific enterprise, the importance of even subtle shifts in the research environment, and the difficulty of reversing downward trends. Furthermore, it is expensive and takes time to improve our teaching

of science; politically difficult to confront the growing influence of the religious right; and hard to get the attention of a public distracted by terrorism, the war in Iraq, and many economic worries in order to explain the importance of science to the nation's future.

My own anxieties are tinged with optimism. Some university leaders, scientists, clergy, and politicians have boldly spoken up to defend the First Amendment, evolution in science curricula, the integrity of science policy-making, and many other things. In some states, the public is ahead of government leaders in appreciating the value of science, especially in controversial areas such as stem cell research and climate change. Science journalism has improved in the past few decades and generally presents our issues

fairly. Portrayals of science in the arts have blossomed on the stage (*Copenhagen*, *Wit*, *Proof*, *QED*), occasionally in the movies, and even this year in opera (*Dr. Atomic*); the Sloan Foundation and others are encouraging more of this. New York's American Museum of Natural History has opened its new Darwin exhibit and is holding public discussions of evolution. And effective popularizers of science, like Brian Greene, a cosmologist at Columbia, are proposing International Science Festivals in our cities, simulating events that have been successful in Europe. All of us can and should become cheerleaders for science. ■

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Harold Varmus (Memorial Sloan-Kettering Cancer Center)



Patricia Meyer Spacks (University of Virginia) and Nannerl Overholser Keohane (Princeton University)



Gerald Rosenfeld (Rothschild North America) and Leslie Berlowitz



John Brademas (New York University) and Frances Degen Horowitz (City University of New York)



Pierre Hohenberg (New York University), Lawrence Shepp (Rutgers University), and Elihu Abrahams (Rutgers University)



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John Kenneth Galbraith Honor Lecture Active Liberty: Interpreting Our Democratic Constitution

Stephen G. Breyer

This presentation was given at a joint meeting of the American Academy and the Cambridge Public Library, held at the House of the Academy on May 18, 2006.

Stephen G. Breyer is Associate Justice of the Supreme Court of the United States. He has been a Fellow of the American Academy since 1982.

It is a great privilege to deliver a lecture named in honor of Ken Galbraith. Among his many considerable talents, Ken possessed a terrific sense of humor. I remember running into Ken after he attended a friend's memorial service. And though Ken was in a foul mood because he did not much care for speeches, the service reminded him of a story. "When Rossini died," Ken told me, "his nephew decided to compose some music to

be played in the great man's honor at the funeral. Afterward, one of Rossini's friends came up to the nephew, and the nephew asked, 'Did you like my composition?' 'Yes,' the friend said, 'I did. But I could not help but think how much better it would have been if you had died and Rossini had composed the music.'" [Laughter]

That is vintage Ken Galbraith. He was – as many in this room can attest – a champion meddler, and he affected my life the year I was clerking for Arthur Goldberg. Ken had come to visit Justice Goldberg, and Goldberg was complaining about life at the Court.

Ken paid a visit to the White House, sat down with Jack Valenti and Lyndon Johnson, and said, "Arthur Goldberg is not very happy at the Supreme Court. You better find him another job." And Johnson said to Valenti, "We need a new secretary of HEW. See if Arthur's interested in the job." Valenti called up Goldberg, and Goldberg declined.

I know this happened because I distinctly remember Goldberg saying to me: "People in this administration are always calling and asking me if I want another job. I have a job." And he truly was – despite periodic complaints – quite fulfilled at the Court. But then

Adlai Stevenson passed away, leaving open the role of U.S. Ambassador to the United Nations. Perhaps, at that point, Ken placed another call to the White House. In any event, Johnson thought appointing Goldberg to the United Nations position was a great idea, and Valenti talked to Goldberg. Based on what I later heard, I understand that the ensuing conversation could be distilled to the following: “Arthur, the most important problem facing the country is Vietnam. I intend to solve this problem with the United Nations. And you’re the only one who can do it.”

Goldberg would have believed all three of those statements. According to Sol Linowitz, Johnson might have added something along these lines: “And you know, Arthur, the man

The Constitution establishes a system of government that offers a way for ordinary Americans to express themselves regarding how their communities should function.

who solves that problem can do anything.” Goldberg might well have believed that, too. I know from Justice Brennan that Goldberg consulted some of his fellow justices about the offer. All of them got along very well with Goldberg, but they thought that the U.N. position was a momentous undertaking and that he should accept the offer – even if it was unheard of to leave the Court.

Goldberg did leave, and while we regret it, he certainly did try. In his autobiography, Johnson wrote that Goldberg had asked for the U.N. job. That suggestion infuriated Goldberg, prompting him to return various presents that Johnson had given him over the years. Goldberg could not understand Johnson’s motivation for asserting that he had requested the U.N. position, but it is not inconceivable that Johnson thought that the statement was accurate. It all depends on what transpired during that conversation with Ken Galbraith, who was a master of tact.

Now let me turn to my book, *Active Liberty*. I wrote this book about the Supreme Court for several reasons. The first reason is that

I have been a judge on the Court for about twelve years now. Incidentally, if Justice Alito had arrived one month later, I would have held the record for longest tenure as junior justice, now held by Joseph Story. I missed, by one month, immortality as an answer to a trivia question. [Laughter] In the book, I explain a major difference between my job on the Supreme Court and my previous job as a judge on the Court of Appeals. Where a Court of Appeals judge considers constitutional matters only sporadically, Supreme Court work involves a steady diet of constitutional questions, which allows a Justice to develop a view of the Constitution as a whole.

Another motivation for writing the book occurred about eighteen months ago, when Justice O’Connor, Justice Kennedy, and I went to meet with Mrs. Annenberg and Vartan Gregorian. In an effort to develop a curriculum to teach high-school students about the Constitution, they surveyed the American Law Institute, which consists of lawyers from all over the country. When those lawyers were asked what part of the Constitution was most important to teach students, most responses centered primarily around three different areas: freedom of speech, freedom of religion, and equal protection of the laws. But far down on the list of responses was a word that all three of us who are Justices believe captures the Constitution’s fundamental principle: democracy.

The Constitution establishes a system of government that offers a way for ordinary Americans to express themselves regarding how their communities should function. The Constitution does not, of course, establish a pure democracy in the sense of a Greek city-state or a New England town meeting. But that ours is a delegated democracy does not undermine its basic democratic nature.

Democracy is central in understanding the Constitution because that document creates a governmental system with certain boundaries. It is the Supreme Court’s job to police those boundaries. Deciding whether a law is on the far, forbidden side of the rails or on the near, permissible side presents a difficult task. But, regardless, in between those boundaries is a vast area where people must determine for themselves – through legislatures, city councils, and various institutions – the kinds of rules they want to govern themselves. It is not the Supreme Court’s job to mandate those rules, but to determine whether the desired rules cross over into forbidden territory.

John Kenneth Galbraith

In opening remarks at the John Kenneth Galbraith Honor Lecture on May 18, 2006, Chief Executive Officer Leslie Berlowitz took note of the death of John Kenneth Galbraith only a few weeks earlier:

As all of you know, Professor Galbraith passed away on April 29, and tonight’s lecture is a small but fitting way for us to pay tribute to his life and spirit. I’d like to say a few words about his special relationship with the Academy.

In addition to being a valued Fellow of the American Academy, he was our next-door neighbor. After returning to Cambridge from his service as Ambassador to India, Ken and Kitty were frequently present at Academy meetings. On one October afternoon in particular, just a few days after Ken’s ninety-fifth birthday, he attended a luncheon here. Richard Parker was discussing his forthcoming biography of Ken. It won’t surprise any of you who knew Ken to hear what he said on that occasion: “Nothing has given me more pleasure over the years than this excellent and elegant organization. While we do not live at a great distance, the journey over here was my longest in nearly a year. I hope that travel marks my affection, my respect, and my admiration for all that the Academy does in revealing life’s deeper lessons. For that, we are all indebted.”

Our indebtedness, affection, and admiration were mutual. Ken was a towering intellect and the epitome of an engaged citizen. When John Adams and the other Founders established the Academy 225 years ago, they recognized that it would take public-spirited scholars and leaders to fulfill its lofty purposes. I think they had in mind people like Ken Galbraith. He was a treasured friend of the Academy, the country, and the world, and we will all miss him.

Two examples illustrate how my views have been influenced by the fundamentally democratic nature of the Constitution. I should

Democracy is central in understanding the Constitution because that document creates a governmental system with certain boundaries. It is the Supreme Court's job to police those boundaries.

note at the outset that I am not offering a theory of constitutional law. A theory, I learned long ago at Harvard Law School, is a complicated matter that invites logical deductions. Although lawyers on both sides of a case may frame their arguments as logical deductions, they invariably deduce opposing conclusions. [Laughter] Instead of a theory of the Constitution, I offer a theme of the document.

My first example, campaign finance, focuses on laws that restrict either the amount of money an individual may give to a candidate, or the amount that a candidate may spend on an election. The Supreme Court upheld the most recent federal law, McCain-Feingold, by a vote of five to four – an outcome indicating that this issue is a complex one. Despite this closely divided decision, some people believe that this issue is straightforward because campaign finance addresses money, and money is not speech. If money is not speech, they ask, how does regulating it interfere with freedom of expression? I find that reasoning totally unsatisfactory because even though money is not speech, the expenditure of money enables speech. If a candidate has no money, that candidate's ability to speak during an election will be severely constrained.

On the other side, many people also believe that campaign finance is an easy question, but for different reasons. Given that money enables speech, these people contend, campaign-finance regulations impermissibly limit freedom of expression. The First Amendment reads: "Congress shall make no law . . . abridging the freedom of speech."

Campaign-finance laws must be deemed unconstitutional, under this view, because they limit speech.

In assessing whether campaign-finance laws are permissible, it is helpful to bear in mind the Constitution's democratic objective. The First Amendment is but part of a larger document, one that guarantees democratic institutions and provides for democratic elections. Indeed, the First Amendment plays an important role in ensuring that people hear different points of view and, through hearing those different points of view, are able to make informed choices in elections.

Considering the Constitution in context suggests that there may be problems with having campaign finance receive absolute protection under the First Amendment. To take an extreme example: imagine that a city has a very wealthy political family that purchases all of the television advertising time. It would be extremely difficult for candidates who were not as well financed to deliver their messages to the public.

As soon as we recognize that both sides of the controversy have attendant First Amendment interests, we shift from asserting absolutes to asking questions: What is the effect of this campaign-finance rule? Will unregulated money serve to drown out voices? How might a law restricting campaign expenditures introduce more voices into the forum? These are the questions that the Court considered in *Buckley v. Valeo* in 1976 and more recently in *McConnell v. FCC*. People may not necessarily agree with the Court's answers to the difficult questions posed by campaign-finance laws, but considering the Constitution's democratic theme can help us to ask better questions.

Affirmative action provides another instance of how this democratic theme can help resolve difficult constitutional questions. Understanding how democracy applies in this context is less obvious, but it applies nonetheless. As you all know, the Fourteenth Amendment provides that no state shall "deny any person . . . the equal protection of the laws." There are two predominant views contesting the meaning of that phrase as applied to affirmative action. Under the first view, affirmative action would be deemed unconstitutional because state activity must be "color-blind." This term comes from Justice Harlan's dissenting opinion in *Plessy v. Ferguson*, where he disputed the majority's notion that racially separate facilities could

in fact be equal. Though that is an admirable antecedent, it is difficult to know what the term "color-blind" now means when state universities seek to use color not to exclude racial minorities, but to create a more integrated society.

In contrast to the color-blind view, the purposive view considers whether the policy is designed to help or hurt racial minorities. Rather than merely reading the Fourteenth Amendment's guarantee of "equal protection of the laws," the purposive view considers the history that produced this guarantee. That history, of course, is grounded in the nation's efforts to end slavery. Though the purposive view forbids laws based on a lack of respect for the disfavored race, it may permit laws that consider race in certain, limited circumstances.

The color-blind view and the purposive view collided in *Grutter v. Bollinger*, where we weighed whether the University of Michigan could consider a law school applicant's race in its admissions process. The briefs in *Grutter* came from a wide array of sources, including universities, trade unions, major corporations, and former officials of the armed forces. The retired military officials indicated that without affirmative action in officer training schools, racial minorities would be excluded from the top cadres in the Army. Similarly, the unions, corporations, and universities expressed a desire

The First Amendment plays an important role in ensuring that people hear different points of view and, through hearing those different points of view, are able to make informed choices in elections.

to maintain affirmative action programs so that they could diversify workplaces and schools.

Justice O'Connor's opinion for the Court in *Grutter* captures the democratic nature of affirmative action when she argues: "Effective participation by members of all racial

and ethnic groups in the civic life of our Nation is essential if the dream of one Nation, indivisible, is to be realized. . . . [Indeed], the path to leadership [must] be *visibly* open to talented and qualified individuals of every

Purpose and consequence are complimented by four additional tools that judges have at their disposal in deciding cases: text, history, tradition, and precedent.

race and ethnicity. All members of our heterogeneous society must have confidence in the openness and integrity of the educational institutions that provide this training.” Without affirmative action, Justice O’Connor suggested, too many citizens would believe that leading institutions – and, indeed, the nation’s governmental processes as a whole – belonged only to people that were different from themselves. That consequence would, I believe, threaten the democratic form of government that the Framers sought to establish.

Grutter illustrates how judges may examine the purposes embodied in a particular text and consider the consequences of various interpretive decisions. Those two tools – purpose and consequence – are complimented by four additional tools that judges have at their disposal in deciding cases: text, history, tradition, and precedent. Although all judges have access to these six tools, a very real divide exists among judges today. Some judges, who call themselves “originalists” or “textualists,” reach judicial decisions relying almost exclusively upon text, history, tradition, and precedent. They acknowledge that the other two tools exist, but they generally do not use them. Other judges – and I include myself in this second group – take a different approach by placing greater emphasis upon purpose and consequence.

I think that this emphasis is appropriate because one cannot go back and determine exactly what the Framers thought about affirmative action. Nor can one determine the Framers’ views concerning radios or automobiles or the Internet. But, whatever their predictive limitations, the Framers certainly

did understand commerce. When I have a case addressing the Commerce Clause, I consider the basic purposes of the Clause, and then apply those purposes to the modern world. Although applications may change, I believe that purposes endure.

If I am correct about how our Constitution works, then at its heart is an insistence upon creating institutions that reflect the democratic will. The Framers erred in excluding large segments of the population from civic participation, but they did understand that civic participation was necessary to ensure democracy. There are, of course, many ways of participating: become a member of a local school board; run for Congress; and, at the very least, vote. But if you do not participate, the Constitution will not work because it is a document that foresees democratic participation. We do not need activist judges, but we desperately need activist citizens.

Discussion Session

Q: Justice Breyer, there are some colleges in this country where you cannot get a degree without being able to swim four laps. Yet I have had college-age students who do not know the difference between a grand jury and a jury. I wonder if it is our constitutional right to remain ignorant of the Constitution, or if the Constitution should be made a mandatory course for high school and college graduation.

Breyer: When I was in high school in San Francisco, we took a course called twelfth-grade civics. It was a basic class that provided students with a pragmatic understanding of our democratic system. Indeed, we learned how the state government worked by going to Sacramento and seeing it in action. I am told that, since the time I attended high school, there are fewer classes that study the processes of government. That decline is deeply unfortunate, and I believe that it is intimately connected to the decline in civic participation in our nation. After all, we cannot expect people to participate if they know nothing about how the government operates.

Q: Do you always feel that the Constitution is written well enough for you to do your job? I have in mind the Second Amendment. When I look at it, as a grammarian, I get rid of the first comma and the third because they would not be grammatical in modern

English. The first clause, “a well-regulated militia being necessary to the security of a free state,” is a subordinate clause that does not make its meaning explicit (but it appears to be intended as if it had, since, at the front, it says you need a well-regulated militia), and then the main clause is clearly “the right to bear arms shall not be infringed,” but it does not say who shall not do the infringing. I look at that and say: “It is too badly written to work with.” I wonder if you ever have that feeling about that or any other provision.

Breyer: Fortunately, I do not think that the Supreme Court has heard a case on the Second Amendment since I arrived in 1994. I do not generally approach cases from a grammatical point of view, in part because the Constitution is written with such broad phrases. These broad phrases, even presuming meticulous punctuation, do not define themselves.

For instance, the Constitution permits Congress “to regulate commerce with foreign nations, and among the several states, and with the Indian tribes.” Suppose that the Framers spelled out precisely what they meant by “commerce.” That approach would have worked quite well for a brief period, but then the steam engine would have been invented and complicated matters significantly. Not long after that, electricity would have followed and complicated matters further still. More recently, the twentieth century saw the invention of two types of highway – automotive and informational – which would

Following the trajectory of the rule of law in the United States reveals that we have now arrived at the point where people will follow decisions even if they disagree with them. In many other countries, people do not share such reverence for the law.

have rendered a specifically worded Commerce Clause utterly meaningless. If the Constitution’s phrases had been too precise,

I may have found them easier to read as a grammarian, but I would have found them much harder to apply in today's world.

Q: After *Bush v. Gore*, is the traditional concept of federal government deferring to the state courts in the interpretation of their own constitutions still intact?

Breyer: People often ask whether I was disappointed with the outcome in *Bush v. Gore*. Of course, I was disappointed. I am always disappointed when I am in the dissent. I occasionally say to my wife, Joanna: "I've written a devastating dissent that is going to convince them. I will get five votes for sure." And she says, "I've heard that one before."
[Laughter]

I do not convince my colleagues every time, but it is a great privilege of my job to write another opinion in an effort to convince them. We do not always see things the same way, and we often feel strongly about our views. But not in *Bush v. Gore*, nor in any other case during my twelve years on the Court, have I heard a voice raised in anger in our conference room. And I have never heard one judge in that room say anything slighting about another. We are professionals who understand the significance of our undertaking.

I cannot say more about *Bush v. Gore* than I wrote in dissent in that case. But I would like to place that case in historical context. In the 1830s, the Supreme Court decided *Worcester v. Georgia*, a case considering who owned the

land in northern Georgia. The Supreme Court, in an opinion written by Chief Justice John Marshall, determined that the land was in fact owned by the Cherokee Indians. Many of you know this case because President Andrew Jackson is purported to have said, "John Marshall has made his decision; now let him enforce it." And Jackson sent federal

The rule of law does not come merely from the words in the Constitution The rule of law does not come only from judges or even from lawyers. It fundamentally comes from ordinary people who follow the rules.

troops to Georgia not to enforce the decision, but to evict the Indians. The result was the Trail of Tears, on which many Indians died.

Now consider *Cooper v. Aaron*, a Supreme Court case that followed *Brown v. Board of Education*. Arkansas Governor Orval Faubus vowed to prevent the integration of schools in Little Rock, and called in the state militia to support that vow. All nine justices signed

an opinion reaffirming that racially segregated public schools were unconstitutional. But even if there were nine thousand justices, they would have been powerless to stop the state militia. What stopped Governor Faubus was President Eisenhower, who ordered paratroopers to take those black children by the hand and walk them into that white school.

Many people were deeply upset with the Court's decision in *Bush v. Gore*. And though that case has spawned many assessments of the Court's decision, I have yet to read about the need for paratroopers. Following the trajectory of the rule of law in the United States reveals that we have now arrived at the point where people will follow decisions even if they disagree with them. In many other countries, people do not share such reverence for the law.

The rule of law does not come merely from the words in the Constitution, whether they are general or specific, grammatical or ungrammatical. The rule of law does not come only from judges or even from lawyers. It fundamentally comes from ordinary people who follow the rules. It is one of the reasons I wrote this book and why I believe so strongly that we must teach our grandchildren about civics in school. The rule of law is not just the responsibility of lawyers and judges – it is everyone's. ■

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Justice Stephen G. Breyer (United States Supreme Court)



Catherine Galbraith and Justice Stephen G. Breyer



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which amounts to about 7,500 pages or 24 megabytes.

Whether debating macroeconomic theory, predictions about the future performance of markets, or any other subject, economists are well known for having different points of view. Yet virtually all of them agree that our nation's system of taxation could be made both simpler and fairer. We are fortunate to have two speakers this evening who are authorities on U.S. tax policy. James Poterba and Michael Graetz are eminently qualified to examine the challenges and choices facing policymakers in Washington. Michael will introduce Jim and then offer his own views on tax reform.

Michael Graetz is the Justus S. Hotchkiss Professor of Law at Yale University. An expert on taxation and tax policy, he has authored or edited six books and many articles on the topic. In addition to a distinguished career in academia, he has served as Deputy Assistant Secretary for Tax Policy in the U.S. Treasury.

Michael J. Graetz

This is the first time I've ever been asked to introduce a speaker, tell you how wonderful he is, and then tell you why he's wrong. But that seems to be my mission tonight.

Jim Poterba has taught at MIT since 1982. He is the Mitsui Professor of Economics and Head of the MIT Economics Department. He has authored or edited numerous books on how taxation affects the economic decisions of households and firms.

Jim's presentation is based on his recent work as a member of the President's Advisory Panel on Tax Reform – a group of nine people who spent much of 2005 reviewing the tax code and developing ways to improve it. Since Jim was the only member of the panel who did not use a paid tax-return preparer, he has an intimacy with the tax law that was missing elsewhere in the panel.

A graduate of Harvard College, Jim received his Doctor of Philosophy degree as a Marshall Scholar at Oxford. He is among the most decent, thoughtful, generous, serious, and engaging people I've ever met. He will ultimately help put the lie to the widespread notion that economics is the dismal science.

Tax Reform: Current Problems, Possible Solutions, and Unresolved Questions

James Poterba and Michael J. Graetz
Introduction by John S. Reed

This presentation was given at the 1898th Stated Meeting, held at the House of the Academy on February 9, 2006.

James Poterba is Mitsui Professor of Economics and Head of the Economics Department at the Massachusetts Institute of Technology. He has been a Fellow of the American Academy since 1996.

Michael J. Graetz is Justus S. Hotchkiss Professor of Law at Yale University. He has been a Fellow of the American Academy since 2004.

John S. Reed, Treasurer of the American Academy, is former Chairman and Chief Executive Officer of Citigroup. He has been a Fellow of the American Academy since 1998.

John S. Reed

In a couple of months – sixty-five days from today to be precise – most of us will file federal income tax returns, or at least ask for extensions. Beyond the effect that taxes have on each of us personally, the structure of the country's tax policy has a direct impact on the national economy and on the government's actions and programs. Title 26 of the U.S. tax code, the Federal Internal Revenue Code, contains more than 3.4 million words,

James Poterba

The Academy's archivist reports that tax policy has never before been discussed at a Stated Meeting of the Academy. Let me therefore begin with some historical background. Colbert, the finance minister to Louis XIV, defined the art of taxation as "the plucking of the goose, so as to obtain the largest amount of feathers with the smallest amount of hissing." Last year, I was part of a tax-reform panel that studied how to collect feathers without hissing and suggested several options for tax-reform. This evening, I will discuss three broad issues in tax policy and tax reform. First, I will consider some of the difficulties in the current tax code. These are elements that are cited as major problems and that motivate the quest for alternatives to the system we now have in place. Second, I will outline several potential directions for tax reform, including both options suggested by the President's Tax Panel and other alternatives that were not suggested. Finally, I will address some of the practical difficulties of reform that plague both current and future attempts to change the tax code.

The tax code is complicated, and it has become more complicated over time.

Let me start by saying just a word about the tax panel that was appointed in January 2005. The group consisted of two former Senators and a Congressman, three academics, and three others with various perspectives, including a former head of the Internal Revenue Service. We were charged with proposing revenue-neutral ways to make individual and corporate income taxes simpler, fairer, and more pro-growth. The revenue-neutral element of our charge must be underscored, because true reform of the tax system doesn't mean tax cuts. It means changing the structure to try to find a better way to raise revenue. Tax reform can be combined with raising or lowering the level of taxation.

Most of the tax panel's work consisted of holding hearings and working with Treasury staff as well as with our own staff to develop reform options. The work usually involved

sober analysis of tax policy and tax law. There were occasional moments of levity, however. Our chair was the former Senator Connie Mack of Florida. His namesake is his grandfather, the Baseball Hall of Famer and legendary manager of the Philadelphia Athletics. At one point, a witness was testifying about a reform proposal that would change how we tax capital gains, so that small capital gains would be untaxed and very large capital gains would be taxed very heavily. The witness labeled this plan the "home run tax." Senator Mack stopped him in mid-sentence and said, "With my heritage, I am deeply opposed to any plan for taxing home runs."

As we studied the current tax code, our panel was able to identify three key problems: the increasing complexity of the income tax; the expanding reach of the alternative minimum tax; and tax-induced distortions in economic activity, which might involve labor supply, saving, or financial choices.

The first issue that motivates many tax-reform discussions is the complexity of the current system. This is the easiest problem to describe, but it is probably the least important of the three justifications for reform. Today, more than 60 percent of taxpayers, finding the tax code just too difficult to grapple with on their own, use a paid preparer to help ensure the accuracy of their tax returns. Estimates suggest that, as a nation, we spend about \$140 billion collecting taxes and complying with the income tax code. We raise about a trillion dollars from the income tax, so we're spending about 15 percent of the revenue yield on compliance. This figure includes not just the checks people write to tax preparers but also the time spent collecting records, preparing returns, and getting financial affairs in order.

The tax code is complicated, and it has become more complicated over time. We have done more and more social engineering through the tax system, for example, by trying to encourage conservation by providing special incentives such as education savings accounts, by using health savings accounts to encourage particular types of insurance purchases, and by providing incentives for various kinds of business investments. Each provision of this type moves us away from a simple system toward one that is more cumbersome to comply with and to understand.

Beyond the broad concern that the current tax system discourages labor supply and investment more than some alternative systems might, there are specific concerns with distortions and efficiency costs created by the tax code.

In 1986, the watershed tax-reform year of the postwar period, the federal income tax was dramatically simplified and reformed. Since then there have been more than fifteen thousand changes to the tax code. Many have added complexity. Until recently, for example, there were five different definitions of "child" in the tax code. There were different definitions for when a child was a dependent, when she could be used to qualify her household for the Earned Income Tax Credit (EITC), and when she could receive a childcare dependency credit. The current tax code also includes more than a dozen different ways to save, in a tax-preferred way, for retirement, education, and health-care needs.

Some of the tax changes since 1986 have involved "rifle shot" provisions: specialized rules that are trying to provide tax relief or a tax incentive, often for just a small part of the economy. Other provisions offer favorable tax treatment to substantial sectors of the economy. A witness who testified before the tax panel illustrated one such provision, the current tax provision for a lower corporate tax rate on firms in manufacturing than in other industries. The witness delivered a box of donuts to the chairman of the tax panel, explaining that the donuts had been purchased at a bakery, where they had been baked on the premises. Because of this, the bakery did not qualify as a manufacturing establishment. However, a mass producer of donuts, which baked its donuts at a common site and delivered them to grocery stores, would qualify for a lower tax rate under the special manufacturing tax credit enacted in 2003. Thus the playing field was not level across donut providers. Provisions

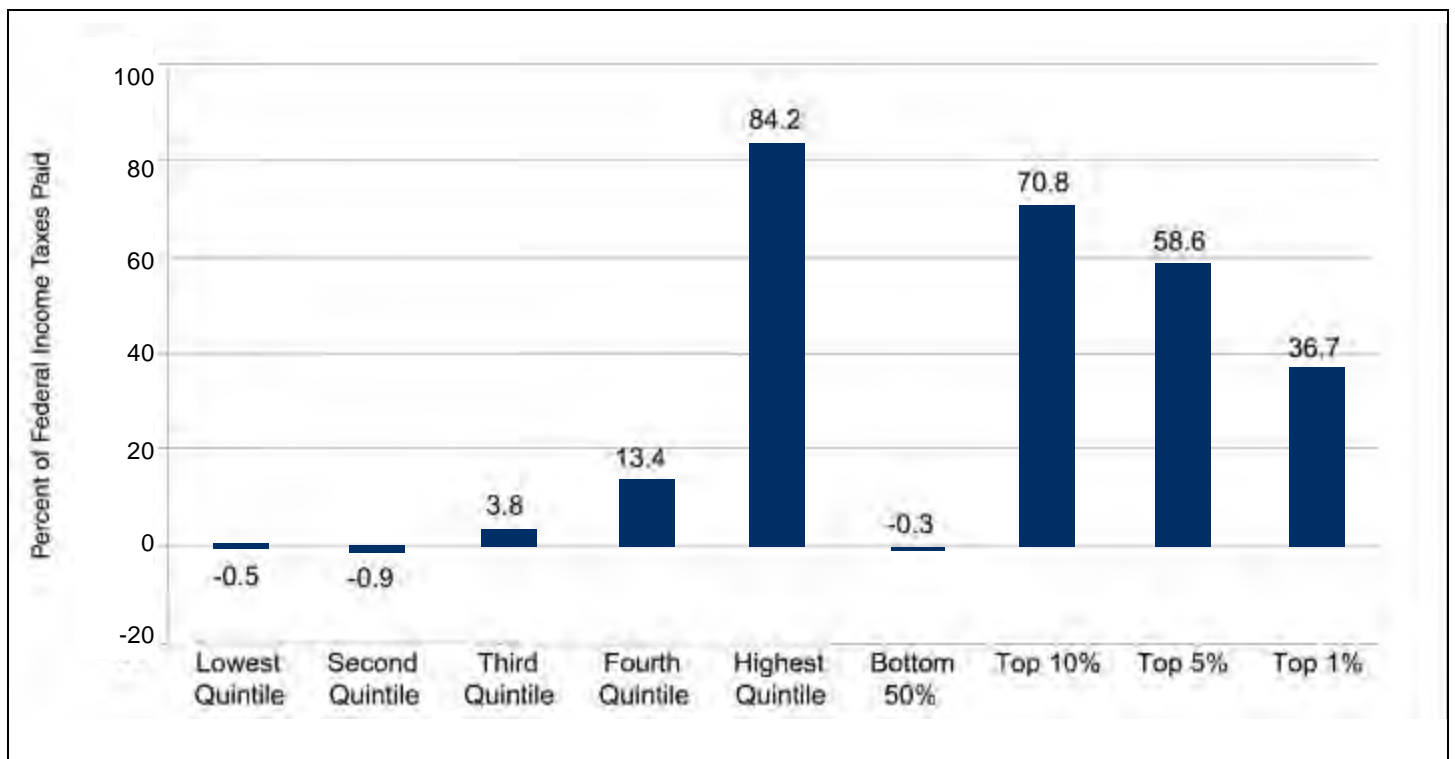


Figure 1: Distribution of Federal Income Tax Payments by Household Income Categories, 2006.
Source: President's Advisory Panel on Federal Tax Reform

like this have complicated the tax code while distorting the economic behavior of households and firms.

In part because of new tax provisions that reduce the tax liability of low-income wage earners with children, a large fraction of households pays no, or very little, income tax, while a small fraction pays the lion's share. Figure 1 demonstrates this.

The first five bars in the figure represent the quintiles of income distribution. The top 20 percent of taxpayers, ranked by income, currently accounts for about 85 percent of the taxes paid under the income tax. The four bars on the right side of Figure 1 provide more detail on the tax payments by those at the top of the income distribution. The top 1 percent pays about 37 percent of the taxes, while in aggregate tax filers in the bottom half of the income distribution receive a refund because of the EITC and the exemptions that absolve households with low incomes from income tax liability. The payroll tax, which finances Medicare and Social Security, begins to raise revenue from households at a much lower income level than the income tax. Even combining the payroll and income taxes, however, taxpayers in the top quintile of the income distribution account for a very large fraction of total taxes paid.

The second issue that motivates many current discussions of tax reform is the recent expansion of the Alternative Minimum Tax, the AMT. The United States today has two parallel tax systems operating in tandem: the regular income tax, which specifies tax

The first approach involves reforming the income tax by lowering rates, broadening the base, and removing as many of the distortions as possible while preserving some sense of fairness.

liability as a function of income and taxpayer characteristics, and the AMT, which calculates tax liability in a different way. After doing both calculations, the taxpayer is asked to figure out which is greater, and then to pay that amount. One of the reasons the AMT is so unpopular is simply because the last step in the calculation involves paying the maximum, not the minimum, tax liability.

The AMT was designed to apply to a broader income base than the regular income tax, and thereby to levy tax on some taxpayers with high gross income but large deductions who face very low regular income tax liabilities. The AMT base includes some things that are traditionally excluded from the income tax base, such as state and local tax deductions. Business and some medical expenses are also added back to taxable income in computing the AMT base. After excluding a threshold amount of AMT taxable income, a taxpayer applies the AMT rates, usually 26 or 28 percent, to Alternative Minimum Taxable income. Because of its high level of state and local taxes, Massachusetts has one of the highest fractions of resident taxpayers facing the AMT.

Of the 130 million households that filed income tax returns in 2005, about 4.5 million paid the AMT. If Congress does not act soon to increase the AMT threshold, then more than 20 million taxpayers will pay the AMT in 2006. Going forward, the growth of the AMT is even more striking. By 2015, 50 million taxpayers, or nearly one in three, will pay the AMT, and about two-thirds of taxpayers with incomes between \$50,000 and \$100,000 will pay the AMT. Virtually everyone with incomes between about \$100,000 and about \$400,000 will be taxed

under the AMT rather than the regular income tax. The cost of repealing the AMT will exceed the cost of repealing the regular income tax.

The second involves reducing the revenue yield from the income tax, and making up the lost revenue with an alternative tax source.

The growing role of the AMT motivates discussions of tax reform for two reasons. First, the AMT creates extra complexity. Some protest that the AMT requires taxpayers to do their taxes twice. For many taxpayers, this may overstate the burden. I use a computer program to prepare my taxes, and once I have typed in all of my data, it's really only one more step to get the program to calculate my AMT liability as well as my regular income tax liability. For some taxpayers, however, the burden is much greater, because the AMT may require recordkeeping or information reporting that is not required under the regular income tax. The second, and larger, issue is that the AMT complicates tax planning. A taxpayer's marginal rate differs under the regular income tax and the AMT. The top AMT rates are lower than the top rates under the regular income tax. Uncertainty about which tax system a taxpayer will face complicates many decisions, such as charitable gift planning. Both of these considerations have placed the AMT at the top of the Treasury Department Taxpayer Advocate's list of the most important problems in the income tax code.

The problems created by the growth of the AMT could be addressed either by repealing the AMT, or by modifying it so that it once again applies only to the very top of the income distribution. The tax panel recommended repealing the AMT – a very expensive action that set the stage for most of our other recommendations. Under the assumption that the 2001 and 2003 tax cuts are permanent, which is built into the administration's baseline budget, repeal of the AMT would cost \$1.2 trillion over the next ten years. Most of the cost falls in the years between 2012 and 2016, when the AMT accounts for a significant share of total revenue. Even if we assume the 2001 and 2003 tax cuts expire in 2010, as they are currently

scheduled to do, repealing the AMT would still cost about \$700 billion over ten years.

By recommending AMT repeal, the tax panel created a large revenue gap that needed to be filled. That is why the panel recommended many base-broadening reforms of the current tax code, such as tightening the limits on mortgage-interest deductions and taxing a fraction of employer-provided health insurance. Each of those reforms could help finance AMT repeal.

The third justification for tax reform focuses on the incentive effects of the income tax system, and the efficiency costs associated with the current structure. The tax system influences behavior of both households and firms. It affects a wide range of decisions, including how much to work, how much to save, and for firms, how much to invest. A central proposition in tax economics is that lower marginal tax rates go along with lower distortions. Raising revenue with a broad tax base and low rates is not nearly as distortionary as raising the same revenue with a smaller tax base and higher rates.

The impact of tax rules on some household and firm decisions is difficult to determine solely on the basis of economic theory, so empirical evidence plays a central role. Consider, for example, the effect of taxes on labor supply. In theory, there are two effects of taxing earnings. An income effect makes the taxpayer poorer and encourages additional work, while a substitution effect recognizes the lower after-tax wage rate and the associated reduction in work incentives. Empirical evidence, based on studies of the 1986 tax reform in the United States and of the 1990 tax reform in Sweden, suggests that when there are sharp reductions in marginal tax rates on earnings, labor supply increases. This suggests that the substitution effect dominates the income effect with regard to labor-supply behavior.

Tax policy can also distort savings and investment. Theoretical studies that compare different tax structures suggest that economic growth would rise if the tax burden on capital was reduced. Yet these efficiency gains may come at a cost in the distribution of tax burdens. Because the ownership of capital is concentrated among a small share of taxpayers, lowering capital tax burdens may make it difficult to achieve what some would view as a fair distribution of tax liability.

Beyond the broad concern that the current tax system discourages labor supply and investment more than some alternative systems might, there are specific concerns with distortions and efficiency costs created by the tax code. The current system treats different types of corporate entities, such as S and C corporations, differently, and thereby provides incentives to structure business activity in one way versus another. Debt and equity, capital gains and dividends, partnerships and corporations are treated differently. Housing is treated differently from other investment assets. All of these distortions create incentives for taxpayers to change their behavior to reduce their tax liability.

Having outlined three concerns with the current tax system, namely its complexity, the role of the AMT, and its effect on efficiency and growth, the next question is what do we do? What are the possible solutions? There are three broad types of reform. The first involves reforming the income tax by lowering rates, broadening the base, and removing as many of the distortions as possible while preserving some sense of fairness. That's one of the options the tax panel proposed. The second involves reducing the revenue yield from the income tax and making up the lost revenue with an alternative tax source. The value-added tax (VAT) is often considered for such a role. A VAT is a type of sales tax: it collects revenue by taxing consumption. If we supplemented the

The third possibility is to go further and literally replace the income tax with a consumption tax.

current system with a VAT, we would be able to reduce income tax rates while still collecting the current level of revenue. The United States is the only major industrial country that does not rely to a significant extent on a VAT structure at the federal level.

The third possibility is to go further and literally to replace the income tax with a consumption tax. This could be done in a variety of ways; the VAT is one of them. Another approach that is receiving a fair amount of popular attention at the moment is the National Retail Sales Tax. Such a tax could replace either the income tax or the

combination of the income tax and the payroll tax. The retail sales tax is sometimes promoted in the United States as an example of an “American” tax because the United States uses the retail sales tax at the state

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level. The VAT, on the other hand, is sometimes portrayed as a European tax because France was the first country to adopt it. If one reads the history more carefully, though, it turns out that something very similar to the VAT was proposed by a Yale economics professor in 1921, in a paper published in the *Quarterly Journal of Economics*, which is edited at Harvard. We cannot credit the Europeans for getting there first!

Another approach to consumption taxation would involve a progressive consumption tax, a tax with a long history. This requires tracking consumption at the household level, so that the tax burden can be levied at different fractions of consumption depending on total household spending. In the United States, a detailed plan for implementation was developed by David Bradford and the U.S. Treasury staff in their 1977 report *Blueprints for Basic Tax Reform*. David, as many of you know, died tragically last spring in a fire. There were many times during the work of the President’s Tax Panel when we kept wishing that we could call David and ask how best to handle a particularly difficult problem of expenditure tax design.

Our limited time this evening does not permit me to describe the detailed provisions of any of the specific proposals that were developed by the tax-reform panel. However, I can offer a rough sense of the panel’s two reform proposals. The first called for simplifying the income tax by broadening the base and lowering rates. The second called for moving toward a consumption-oriented tax

system, by adopting a hybrid structure that combined a consumption tax with a flat rate tax on household capital income.

The challenge in the first approach is that to lower rates, one must broaden the base to raise enough revenue to offset the lost revenue that rate-reduction implies. That means attacking some of the expensive and popular deductions that are currently in the tax code. Take the favorable treatment of owner-occupied housing, for example. Today, the failure to tax the imputed rent of owner-occupied housing, while still permitting deductions for mortgage-interest payments and property-tax payments, accounts for about \$142 billion of lost revenue. To place this in perspective, we collect about a trillion dollars each year from the corporate and individual income tax. Employer-provided health insurance accounts for another revenue hit of \$126 billion. Pensions, IRAs, and 401(k) contributions are another \$118 billion; state and local taxes, another \$56 billion. “Base broadening” is a popular concept, but when the specifics of lost deductions become apparent, the political economy of achieving it is very difficult because of the need to limit some of these very popular deductions.

The second approach recommended by the tax panel, which combines a consumption tax structure with a vestigial income tax, is more complicated to explain than the first recommendation. It involves a cash-flow tax, a tax that is similar to a VAT but allows for a deduction for wage payments at the business level. At the household level, this proposal combines a progressive tax on wage income with a flat-rate tax on capital income. Thus the proposal involves elements of both consumption and income taxation.

One of the traditional challenges in designing a consumption-based tax-reform proposal has been achieving distribution goals. Consumption taxes tend to fall more heavily on those who consume a lot relative to their income, typically those near the bottom of the income distribution, than on those with lower consumption-to-income ratios. One way to address this problem is to give each household a rebate from the government to cover tax payments on a bundle of necessities. But options like that complicate the tax structure, require much more recordkeeping at the household level and on the part of the tax administrator, and may create opportunities for evasion. One of the discoveries of the tax panel’s research was that a hybrid

structure of consumption and income taxes could come close to replicating the current distribution of tax burdens throughout most of the income distribution.

Many have heard the description of the various tax-reform alternatives and have asked what gains would justify such reforms. Estimates by leading tax economists, including Larry Kotlikoff of Boston University who is here this evening, suggest that aggregate economic output could rise by as much as 5 percent, after twenty years, if we moved to a consumption tax rather than the current income tax system. That gain dwarfs the differential costs of complying with different tax systems. Ultimately, the tax panel realized that growth was the key issue to consider in tax reform, subject to the constraints of preserving a fair distribution of burdens.

One of the difficult realities of tax reform is that it is hard to get from where we are to some of the more attractive alternatives. First, it is very hard to explain to the public how to think about these different tax systems and their effects. There is broad confusion about a central point in tax economics, namely that taxes collected from firms ultimately are paid by individuals, either in their role as investors or as workers. This creates a political bias toward collecting taxes from firms rather than individuals. In a similar vein, there appears to be some confusion about the differences between various types of consumption tax reforms. The VAT, which is collected in steps throughout

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the production and marketing process, is ultimately very similar to a retail sales tax that is collected only at the point of purchase. Yet many who oppose one of these taxes favor the other, which raises an educational challenge for economists and tax-policy practitioners of all kinds.

A simple example can illustrate the difference between a retail sales tax and a VAT. If

a wheat farmer sells \$100 worth of wheat to a baker, and the baker sells \$200 worth of bread to a consumer, a retail sales tax at 10 percent would collect \$20 from the consumer at the point of purchase. The VAT is essentially a retail sales tax that is collected in stages. It would collect \$10 from the baker and \$10 from the farmer because each of them added \$100 to the total value. Thus the VAT and the retail sales tax have similar economic effects.

An even larger problem, however, is the need to consider transition relief in tax reform. It's very likely that if we put a bipartisan group of nine economists and tax lawyers in a room and said, "Design a tax system," they would come up with a system that differs from the one we currently have in place. Whether it would look exactly like the proposals of the tax panel, I'm not sure. But it would not look like what we have today. However, the challenge is to get from where we are to any of these reform options. The key problem is the entrenched interests that have taken action based on the current tax system and would lose under some of the alternatives.

A standard canon of tax economics holds that taxes on things that cannot be changed are very efficient taxes. Imagine, for example, that you've just built a new rental apartment building. You've got a long stream of tax-depreciation claims that you're hoping to get under the current system. Now say we eliminated those and said, "Tomorrow we're going to adopt a new tax rule. You can't take those claims anymore. But, because we don't have those deductions, we'll tax your income at a lower rate." To an economist, this plan seems like a way of collecting revenue without any distortion because the building will not change – it is the result of past investment. To most other participants in the economic system, however, including all the business people on the tax panel, this example seems like a route to bankruptcies, disruption, and all kinds of other problems. These are important and valid concerns, and they raise the challenge of determining how to change the tax system without creating a great many distortions. If we provide generous relief to those who lose tax benefits that they had previously counted on, then it is more difficult to reduce tax rates in the reform environment. This means the efficiency gains are smaller than they might be if transition relief was more limited.

In considering tax reform, it is essential to recognize that the three objectives that our tax panel was charged to achieve – to simplify, to be fair, and to improve economic growth – are often in conflict. There are trade-offs among these goals, and it is difficult to find reforms that achieve all three. If we want to have a system that is fair, we may need to complicate the structure a bit. If we want to promote growth, it may mean moving toward taxing capital income less, which could have distributional consequences that some might brand as unfair.

Colbert knew that designing a tax system was hard. Louis XIV didn't have much success with the systems that he tried. The United States has had a relatively stable tax system, and one that by and large has worked well. Yet there is a never-ending chorus of calls for reform, but little action. Bill Archer, the former Chairman of the Ways and Means Committee, said, "There's a tremendous appetite for tax reform in Washington until people find out what it really is." Perhaps that explains this paradox!

Michael J. Graetz

Jim and I agree entirely on what's wrong with the existing system. My list is pretty much the same as his, beginning with complexity. I would also add the fact that neither the public nor the overwhelmed IRS can comply with the existing system. I also agree with his points on the AMT.

I do want to add what I call the problem of chicken soup. It refers to the fact that the Congress and presidents of the United States now use the tax code the way my mother used chicken soup, as a remedy for whatever ails society. For example, whenever we have a crisis in health insurance, the President in his State of the Union address will propose a new tax incentive – this time for health-savings accounts. Everyone has a different idea about how to go about solving these social and economic problems, complicating matters further.

Jim mentioned the five definitions of a child in the tax code. There are also thirteen different provisions that provide incentives for higher education, including two tax credits for higher education: one is available if you were convicted of a felony drug crime; the other one is not.

To describe the income tax today, I want to refer back to Jim's figure about the distribution of the income tax burden. The income tax has changed. Prior to World War II, it affected only a very thin slice of high-income earners. In order to finance World War II, however, the income tax was extended to the masses. As recently as the 1986 reform, it was still a mass tax. But in the past two decades, largely through the expansion of the Earned Income Tax Credit (EITC) and child tax credits, more and more people have come off the income tax rolls.

Of the 130 million returns filed each year, nearly a quarter are not taxable. Most of them collect money from the government. Thus, the IRS is not only a tax-collection agency; it is our principal check-writing agency. The amount of refunds paid out for

In terms of collecting money, we're now back to a situation where most of the money is coming from a thin slice of upper-income Americans, not from the masses who used to pay it.

the EITC now exceeds, by a factor of two, the amounts that are paid for welfare, the so-called TANF provisions. There are more refunds now in earned income tax credits than in Supplemental Security Income (SSI), which provides income for low-income people. So the EITC has become our largest social-welfare program, and it is in the tax code. And it is enormously complicated, not only for reasons that Jim has suggested, but also because it creates huge marriage penalties for people at the bottom.

For the middle-income group, tax credits also add complexity. Do I take this education credit? If I draw money out of my education IRA, I lose my credits. Who can figure this out? Maybe TurboTax or a tax preparer can, but this complexity alienates the public from the government when they file their tax returns. Paying taxes is no longer an act of patriotic pleasure. It's not a patriotic act of figuring out your share of funding civilization, except for the few econo-

mists who do their own returns. Most people don't look forward to April 15 – and not because they owe money. Many are receiving refunds.

At the same time, the bottom-half of the population is not paying income taxes but is receiving checks. And two-thirds of the income tax revenue is coming from the top 10

We need a tax system that could actually produce some more revenue, if we need more in the future.

percent. In terms of collecting money, we're now back to a situation where most of the money is coming from a thin slice of upper-income Americans, not from the masses who used to pay it.

The panel has come up with two tax-reform proposals. The first is a really thoughtful reform of the income tax; I compliment them on it. But it is not surprising to me that no politician in America, including the president who commissioned them to undertake this assignment, has picked up on this plan and said, "Let's have it." The reason: the slaughtering of sacred cows. People focus on the loss of deductions – home-mortgage deductions, particularly, but also charitable deductions. People would also lose their state- and local-tax deductions, which makes a difference in what are called the blue states, most of which, including this one, have Republican governors. So, when you start repealing state and local taxes, it's a bipartisan problem.

What would people get out of this reform? One benefit is the repeal of the AMT. However, only four million people are paying it right now, with only the threat that everybody will have to pay it down the road. The typical political response is to "wait and see." The other benefit is that the panel would lower the tax rate from 35 percent to 33 percent. Ronald Reagan lowered the top tax rate from 70 percent to 28 percent; when you make that kind of reduction, you can slaughter a few cows along the way and simplify the law. But when you're lowering the top rate from 35 percent to 33 percent, please leave my cows in the yard. The income tax proposal, while worthwhile, is not one that I

would put a lot of money on crossing the finish line.

The other proposal is the so-called growth-and-investment tax. I love the label. The income tax, as we know, is a tax on income, but the growth-and-investment tax is not a tax on growth and investment. We don't know what kind of tax it is: it's a mystery tax. David Bradford used to call it the X tax, which also had a little mystery about it.

The growth-and-investment tax is a hybrid between an income tax and a consumption tax. What's most interesting to me about this consumption-tax exercise is the emphasis on American exceptionalism. Bob Hall and Alvin Rabushka had to invent the so-called flat tax. David invented the X tax. The panel invented the growth-and-investment tax. The fair-tax people proposed a sales tax at rates much higher than those used anywhere in the world. But, lo and behold, there is actually a very well-functioning consumption tax used not just in Europe but in 150 countries throughout the world: the value-added tax, which collects the money that it's supposed to collect at very low compliance costs compared to ours. Nobody wants to talk about the VAT because it's the "French tax," or the "European tax," or something else. But it has the advantage of working well. I testified before the President's panel, suggesting that what we needed was a third plan that involves a VAT.

Let me say something about the VAT. I do not believe that we can have a revenue-neutral tax system for very long. Jim emphasized that we cannot have any more tax cuts, because the panel assumed all of the President's tax cuts are permanent. In January 2001, Alan Greenspan famously testified to the Budget Committee of the U.S. Senate that the surpluses, which were then estimated to be \$5 trillion over the coming decade, were so large that we would pay off all the nation's debt and have so much money left over that we would have to invest public dollars in private assets, including corporate stock. And he – and I agree with him – said: "The government shouldn't buy corporate stock; it shouldn't be in that business." So, he added, we need a tax cut. Well, the good news is now that Alan Greenspan has left the government, that problem has been solved.

The bad news is that we have more than \$8 trillion of debt. The Secretary of the Treasury is back before Congress, asking to raise

the debt ceiling of the United States to \$9 trillion. We have hundreds of billions of dollars in annual deficits as far as the eye can see, and we have a tax system that is not well designed to raise money going forward. Further, we have a demographic problem: the population is aging. The Social Security problem, where George W. Bush spent his political capital, is a very small problem compared to the Medicare and Medicaid problems. Estimates predict that about 27 percent of our nation's GDP will be spent on the benefits we currently receive from those programs. Historically, we've spent 20 percent of GDP on all federal spending. Perhaps we can keep it at 20 percent or 21 percent by restructuring spending programs. However, our current tax system is raising only 17.5 percent of GDP. The tax panel has come up with a revenue proposal that's revenue-neutral: it gets rates down by 2 percentage points, but it doesn't raise any more revenue for us. So, we have a gap between 17.5 percent here and 20 or 21 percent there. It doesn't add up.

We need a tax system that could actually produce some more revenue, if we need more in the future. People fear a VAT because it just might work. If we need revenue, we could get it. I've come up with a four-step plan that says, "Let's use the VAT," because I'm in the same camp that says, "We ought to be taxing consumption a little more than we do now, and income a little less."

First, instead of repealing the AMT, I would repeal the regular tax. Why? Because the AMT's rates are lower and its base is broader, two objectives that the panel is struggling

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to achieve with its tax-reform proposal, which only gets the income tax rate down to 33 percent. I would get it down to 28 percent by repealing the regular tax. Also, in 2015, with all the people paying the AMT, it's cheaper to repeal the regular tax than it is to repeal the AMT. So I would repeal the regular tax, keep the AMT, and then raise the exemption to \$100,000 for a married couple (indexed for inflation). Thus, no married

couple with a combined income of less than \$100,000 would pay the tax. I would then lower the rate further to 25 percent, maybe less.

I would also apply similar measures to the corporate tax. In the last two decades, this nation has gone from having the lowest corporate-tax rate in the OECD to having one of the highest. Corporate-tax rates have been coming down around the world because people can move money around and the international income tax system is so archaic that it cannot, now, effectively collect high corporate taxes. One way to decrease the incentives for corporations to move money to countries with lower tax rates is to become one of those countries. So, countries throughout the OECD have lowered their tax rates. I would lower the corporate-tax rate also to 25 percent, or lower.

When we lower the individual and corporate income tax rates, these taxes in the United States as a percentage of GDP would comprise about 4 percent, compared to their current 10 or 11.8 percent, of GDP. These two measures would make these income taxes as a percentage of GDP lower in the United States than in any of the OECD countries.

Then I would enact a VAT. As a percentage of GDP, the United States relies much less heavily on consumption taxes than any of the other countries in the world with whom we compete. The VAT would replace the revenue lost by taking all of these people out of the income tax structure, raising the tax-free level to \$100,000, and lowering the rate to 25 percent. We would need somewhere between a 10 and 14 percent VAT to do that, depending on our value-added tax and income tax bases. That 14 percent tax would put us at about the same level as consumption taxes in the OECD and Europe.

I also would suggest a substitute for the EITC: refund some payroll taxes and do not require people to file tax returns in order to get their refunds. Here's the payoff: of the 130 million tax returns now being filed, 100 million disappear, leaving roughly 30 million returns and making April 15 just another day for about 150 million people.

I wouldn't get rid of the income tax completely, as many people want to do. I keep it to avoid the shift in the distribution of income that would result if we didn't tax some of the income at the top. Jim talked about

the need to tax capital for the same reasons. I would also tax capital, but at low rates.

One final point: I do not think that the growth-and-investment tax can work. Two types of individuals missing from the panel were a practicing tax lawyer and a tax accountant. As a result, the panel lacked certain practical experience. The responsibility for this shortcoming belongs to Alberto Gonzales. He told tax lawyers and tax accountants that if they served on this panel, they could have no dealings with the IRS during the panel's life because of the appearance of impropriety. That mandate pretty well ruled them out.

In order to move forward politically, we're going to have to think about alternatives beyond those in the panel's report. . . . Tax reform will involve many hard choices.

The growth-and-investment tax – and the panel recognizes this – has two major problems. First, it doesn't work for financial institutions because of a number of technical issues. The bigger problem is that the tax doesn't work internationally. The growth-and-investment tax would require us to renegotiate all 86 of our bilateral income tax treaties throughout the world because this tax prohibits a deduction for interest at the corporate level. Our treaties provide that, in order to have an income tax, a country has to have a deduction for interest. The tax would also be border adjustable (meaning it assesses imports and exempts exports), but we can't legally put that into effect under the General Agreement on Trade and Tariffs (GATT). So, we would have to convince Congress as well as all other countries to renegotiate the GATT – a transition problem that is very different from the usual transition problems in tax reform.

In order to move forward politically, we're going to have to think about alternatives beyond those in the panel's report. I proposed the changes I have just discussed to the panel, and it did not unanimously accept

them. Enacting a VAT is not easy, politically. Tax reform will involve many hard choices.

James Poterba

Michael has done an outstanding job of outlining some of the open issues and shortcomings of the proposals offered by the tax-reform panel, and of explaining his own alternative reform proposal. His plan involves a VAT, and I should comment briefly on that element. The tax-reform panel spent a good deal of time thinking about the VAT and learning about how it would work. I think there was broad agreement that it, in fact, is a very efficient way of raising revenue. Michael accurately portrayed the concerns that worked against recommending this tax: some panel members were extremely worried that this would be such an effective revenue-raising device that it would lead to growth in the size of government. As one of the jokes about the VAT goes, "the reason we don't have one is because the Republicans think it's a money machine and the Democrats think it's regressive, and as soon as they switch sides, we'll enact one immediately."

Questions and Answers

Question: Judging by the reaction to your thoughtful report, there seems to be a difference between what may be economically sensible and what may be politically possible. One of the concerns about a consumption or value-added tax must be the 76 million baby boomers, who have made a lot of income that's been taxed and who are now entering their retirement years. They're going to spend that income, and it's going to be taxed again as they consume. Moreover, these are the politically active people who vote. Could you talk about the political realities and what might be possible, especially as you transition from an income- to a consumption-based tax?

Poterba: Let me start by explaining the basis for this question, just to make sure everyone understands the problem it alludes to. Envision a situation in which you earned income last year and paid the 35 percent income tax on it. You've got \$10,000 saved outside an IRA to help fund your retirement spending.

Taxing old saving again has some appeal from the standpoint of economic efficiency, but it may be viewed as unfair and it does raise the problem that taxpayers may fear future double taxes.

And now Congress announces that it is going to eliminate the income tax and replace it with a national sales tax at a rate of 30 percent. In some sense, your \$10,000 in the bank has just been reduced in value, because now you're going to have to pay the sales tax at 30 percent, whereas you used to think of the sales tax as a nominal state-level tax. Those who have accumulated assets under the old rules are hit by the consumption tax going forward. Notice, by the way, that if you had put the money into an IRA or a 401(k) where it wasn't taxed the first time out, then you're all right, because instead of paying the income tax when you make a withdrawal from one of these accounts, you now pay the consumption tax instead. But for those with retirement saving or other wealth in taxable accounts, there would be a double tax.

Taxing old saving again has some appeal from the standpoint of economic efficiency, but it may be viewed as unfair and it does raise the problem that taxpayers may fear future double taxes. Taxing past saving makes it possible to lower all marginal rates going forward because it yields revenue that would otherwise have been collected from taxes on wages or future capital income. Unfortunately, such a tax would also lower the standard of living of the people who saved before. Now, there are some who will argue that that has some appeal because the baby boomers are the ones who, as Michael's comments suggested, are going to put tremendous fiscal strains on our system when they receive Social Security and Medicare and Medicaid. To finance some of that with a consumption tax as they draw down their assets may be a way of getting them to pay for that on a pay-as-you-go basis. But the AARP has figured this out, and they are actively explaining to the elderly and not-so-

elderly that they will be double-taxed under these systems. Thus, politically, it may be very difficult to tax the existing assets.

Graetz: I just want to emphasize one thing that Jim said. It's only a double-tax for the income that's already been taxed and not for income that's going to be taxed. If you have investment income, it would be taxed under the income tax. If you have pension income, it would be taxed under the income tax. If you have Social Security income, and you've got more than \$25,000 of income, it would be taxed under the income tax. Consequently these people are going to pay a lot of income taxes. At least under my plan, the taxes balance out because if they pay lower income taxes, they pay higher consumption taxes. The people at the very top-end are paying more than they would because it's basically a 39 percent total rate, rather than a 35 percent total rate, if they consume everything. But somebody's got to pay for government.

Question: My question goes to the longer history of taxes and growth since World War II and the observation that some have made that during the first thirty years after World War II, when tax rates were substantially higher at the margins, we had much better growth than we've had in the last thirty years, when tax rates have been lower. So, is the appropriate growth-and-investment tax one with higher marginal rates?

Poterba: Economists love to point out the difficulties of drawing strong inferences from what are called time-series correlations. Yours is an example of how it's hard to control for all the other factors that were contributing to growth: the stock of knowledge accumulated in World War II, the baby boomers entering into a highly productive period, the growth in the U.S. educational system.

Economists draw information by looking at more narrowly focused experiments. For example, when we enact bonus depreciation for a couple of years, do we see more plant and equipment investment? When we compare countries with higher versus lower tax burdens on capital income, do we see somewhat higher investment rates in places where the tax burdens are somewhat lower? When we find rare experiments that are generated by either tax reform or by circumstances that individuals face, do we see them basically saving a bit more when the tax burdens are lower than when these burdens

are higher? In most of those cases, there's a body of evidence that is not absolutely convincing, but that suggests that if we had lower tax burdens, we would see more saving and investment, which would lead to more growth.

One of the important challenges to recognize is that in an increasingly global economy, encouraging saving and encouraging investing are different things. In a closed economic system such as a single isolated country, when individuals save, the resources get invested in the economy. This leads to a larger productive capital stock and higher productivity. In an open economy, however, when policy encourages individuals to save – in the United States, for example, by building bigger 401(k)s and bigger IRAs – the most productive place to invest those new resources may be in another nation. In this setting the saving country does not get a larger capital stock. Instead, its residents receive the return, later on, on their capital investment abroad. In the U.S. case, these insights suggest that we could encourage investing without encouraging saving by making it more attractive for foreign corporations to invest here. The open global capital market can make it difficult to interpret statistics like the ones that your question mentioned.

One of the important challenges to recognize is that in an increasingly global economy, encouraging saving and encouraging investing are different things.

Question: The VAT does influence trade, thus affecting the trade deficit, per se. One of the primary reasons the Europeans decided to push more on the VAT is because it helps their trade. When I talk to people in other countries, including in the United Kingdom and France, they're very much aware that the VAT gives them a big advantage in world trade. Right now, the United States has a huge trade problem. Would you speak to the one point you didn't discuss – the trade deficit.

Graetz: Just so everybody understands, a value-added tax gives you a trade advantage compared to a corporate income tax because you're taxing imports and exempting exports. So you've increased the price of imports relative to exports. Today, we're importing so much more than we're exporting

...a value-added tax gives you a trade advantage because you're taxing imports and exempting exports.

that changing that price looks like something you might do. I've had these debates with economists endlessly, and the economists will tell you that it doesn't matter because exchange rates will shift and wash out the difference completely. But this assumes that exchange rates move freely, and at least some of our big trading partners – China comes to mind – don't seem too willing to let their exchange rates move quite so freely.

Although it didn't count the revenue from the tax on imports that it would get, the panel decided to make this growth-and-investment-tax proposal border-adjustable in the same way that the VAT is. The problem, which they acknowledge, is that border adjusting is illegal under the GATT, because there is a deduction for wages. Here is another argument for going to the standard VAT.

Poterba: Let me begin by clarifying the standard economic analysis of border adjustments. Think about the current world of an income tax, and the decision of whether to buy a doll produced in China versus a doll produced in Arkansas – there's a level playing field there. Now move to a world where we have a sales tax. The sales tax, presumably, gives you the same level playing field – everything's getting taxed, so there's no greater incentive to buy something produced in one place versus another. Even when goods come into the country from China, provided they are charged the sales-tax rate, the neutrality proposition remains true. Note that the tax is collected on goods coming into the country, but not on goods that are shipped abroad. This observation implies that the retail tax would be collected on goods coming into the country, but not on domestically produced goods that are

being shipped abroad. That's the standard argument made for a sales tax or a VAT: we collect the tax on the imported goods and do not collect the tax on the exports; therefore, the tax promotes exports.

The economists in the audience can see that with flexible exchange rates, the exchange rate can undo the effect of taxing the goods coming into the country and not taxing the goods going out. Michael's comment about what happens when the exchange rate is not free is the first important argument.

There's a second one, though. Consider a world with no taxes, and then ask if putting in place a VAT or a sales tax would help your trade balance. Many economists would say, "The answer to that question is no," and expect rather to see changes in the exchange rate. But ask, "What if I replace the corporate income tax or the individual income tax with the sales tax, and I reduce the tax burdens currently levied on capital income in the United States, putting a tax on consumption instead?" Then – and this is the part that doesn't get emphasized enough – the economists will line up with the business people and say, "Yes, in fact, this is a system that is going to promote capital investment and exports because it's lowering our cost of doing business." So you're right: there would be some pro-export effect of moving to these kinds of systems, but it is not because we do not tax the exports. It is because we replace other taxes that burden exports with the sales-tax structure.

Question: The difference between the European systems and the American one is that the chicken-soup effect is far smaller there. You don't use the tax system to solve various social ills. I think this is probably more important than the VAT. What do you think about that?

Graetz: I have two things to say about it. First, the reason the United States uses the tax system in instances where the rest of the world uses other forms of social insurance is a political and historical story, not an analytical one. I think it's very important to eliminate the filing of tax returns by a very large swath of Americans in part because most of these very costly provisions – sacred cows, including education expenses, the health accounts, and so forth – are not special-interest provisions; they're general-interest provisions. They're enacted to help the broad taxpaying public. If we removed

people making incomes below \$100,000 from the tax system, though, politicians would lose the benefit of saying, "Well, we're going to give you a tax break for this."

In completing a book on social insurance, I discovered that doing social insurance through the tax system doesn't work. You end up rewarding the top-half of the income scale and creating all sorts of strange incentives. The health-insurance system is a perfect example. We have this tax-preferred way of doing health insurance – what are the results? We've got the highest health costs in the world, more uninsured people than elsewhere, and no better health outcomes. Health insurance is the Titanic of domestic policy. It doesn't work.

We have to change the political incentives. In order to do so, we have to get masses of people out of the income tax because that's where all of this politicking has been taking place. If we had a pure income tax, or a growth-and-investment tax, or even the flat tax of Hall and Robushka – where people would supposedly file postcard returns because we would tax only wages for individuals – it wouldn't be a postcard for very long. Because if all of those people are paying taxes and filing returns, the incentives for U.S. politicians are just too great to reward them with a tax break for this or that. And politics will continue, and reform will unravel, just as the 1986 Act has unraveled in the last two decades.

I don't think there's a solution short of really narrowing the scope of the income tax so that it really does become a special-interest issue and not one for the broad public. ■

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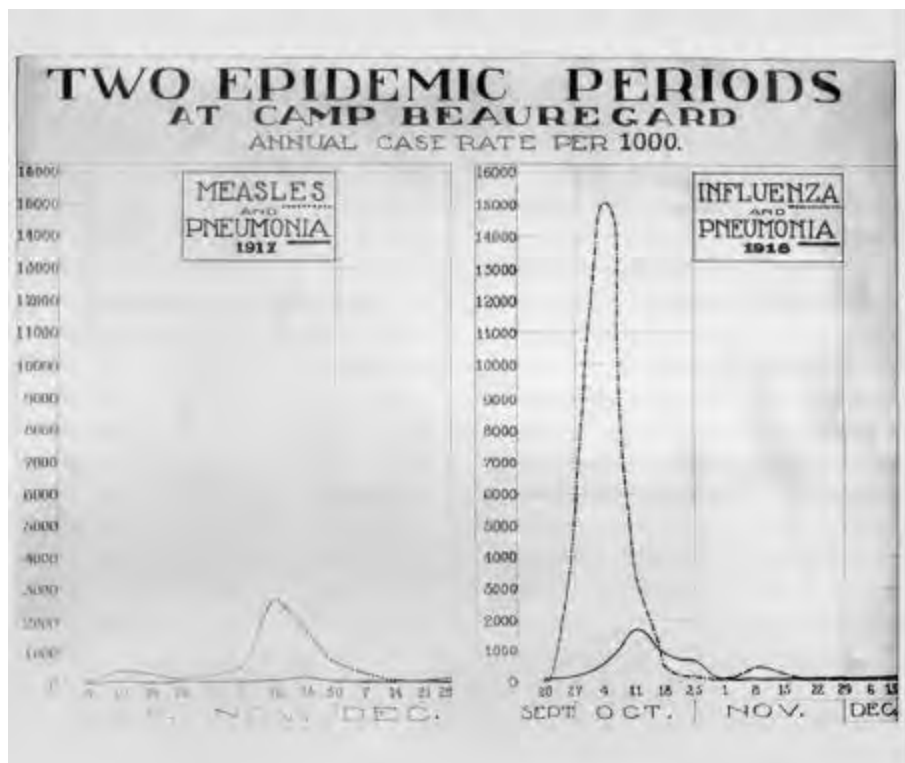
Michael J. Graetz (Yale University), John S. Reed (Citigroup), and James Poterba (MIT)



Benoit Mandelbrot (Pacific Northwest National Laboratory) and Herman Chernoff (Harvard University)



Elias Gyftopoulos (MIT) and George Hatsopoulos (Pharos, LLC)



Courtesy of the National Museum of Health and Medicine, Armed Forces Institute of Pathology, Washington, D.C. (Reeve 2707).

Preparing for Pandemics

Barry R. Bloom and Howard Koh
Introduction by Joseph Boyd Martin

This presentation was given at the 1899th Stated Meeting, held at the House of the Academy on March 8, 2006.

Barry R. Bloom is Dean of the Faculty of Public Health and Joan L. and Julius H. Jacobson Professor of Public Health at the Harvard School of Public Health. He has been a Fellow of the American Academy since 1990.

Howard Koh is Harvey V. Fineberg Professor of the Practice of Public Health and Director of the Harvard School of Public Health Center for Public Health Preparedness.

Joseph Boyd Martin is Dean of the Faculty of Medicine and Caroline Shields Walker Professor of Neurobiology and Clinical Neuroscience at Harvard Medical School. He has been a Fellow of the American Academy since 1980.

Joseph Boyd Martin

It's difficult to get through the day without reading about influenza, bird or avian flu, pandemics, flu shots, or impending disasters

in general. Today, I received the March 3, 2006, issue of *Science*. The two lead articles in the news section are on H5N1 avian flu. The first comes from an investigator in Italy, Ilaria Capua, who is concerned that data collected on migratory patterns of birds affected by the flu are not published quickly enough to develop the science of migration. Instead, she argues, the need to gain recognition for one's work and elevate one's status in academia is delaying the publication of the databases that would give us a sense of how this potential pandemic might emerge. The second article focuses on the clear evidence we now have implicating migratory birds in the H5N1 spread; we now know that sick birds can fly to distant sites, where they may then transmit the problem to other birds.

Tonight, we have two experts, Barry Bloom and Howard Koh, who will approach the topic of pandemics from different perspectives.

Barry Bloom is Dean of the Harvard School of Public Health and the Joan L. and Julius H. Jacobson Professor of Public Health. He received his B.A. from Amherst College, his M.A. degree from Harvard University, and his Ph.D. from Rockefeller University. Widely recognized in the field of infectious diseases, vaccines, and international health, he was elected President of the American Association of Immunologists in 1984, and President of the Federation of American Societies for Experimental Biology in 1985. Formerly a Howard Hughes Investigator at the Albert Einstein School of Medicine, Bloom came to Harvard seven years ago to become Dean of the School of Public Health.

Howard Koh is Harvey V. Fineberg Professor of the Practice of Public Health and Director of the Harvard School of Public Health Center for Public Health Preparedness. He graduated from Yale College and Yale Medical School; trained in residencies at Massachusetts General Hospital and at Boston City Hospital; received a Master of Public Health from Boston University; joined the faculty there; and, in 1997, was appointed by Governor Weld as the Commissioner of Public Health for the Commonwealth of Massachusetts – a position he held for six years. As Commissioner, Dr. Koh led the Department of Public Health, which encompasses a wide range of services, four hospitals, and a staff of over 3,000 public-health professionals.

Barry R. Bloom

We live in a world where about 1.2 billion people live on less than a dollar a day, and almost half of the global population lives on less than two dollars a day. The disparities – in health as well as income – are probably greater now than they were in 1970. More people are living in poverty, and half a billion kids in this world are hungry. At the same time, 200,000 people are born every day. Another important demographic factor to consider when examining infectious diseases is the formation of megacities – cities with more than 5 million people. By 2015, the world will have 37 of those.

Some other social, environmental, and political realities to consider: In a very large number of countries, over 40 percent of the

population is under the age of 15; if not healthy and educated, they will not contribute to the economic and cultural development of those countries. Global warming is going to have profound effects on the patterns of infectious and vector-borne diseases; and, as the oceans rise because of the melting of the polar cap, many countries, like China and those in the Middle East, are going to have real problems with shortages of water. And don't forget, we are trying to deal with health problems in a world that has had about 30 civil and foreign wars, 35 million displaced people, and 127 failed states in the last 40 years. It's tough to do public-health work in those circumstances.

So what does an epidemic look like? Let's begin with a hypothetical situation: Imagine that, on September 12, we detect a case of a flu-like illness. A week later, there are 6,500 cases. A week after that, 12,000 cases and 627 deaths. In a few months, this agent infects a quarter of the civilian population. And in six months, 20 to 40 million people die. It turns out this case is not hypothetical. Those are real data from Camp Devens, Massachusetts, in 1918. During that time, in this country, a half percent of the people infected with the great flu died from it. Globally, the number of deaths was probably on the order of 4 percent, somewhere upwards of 50 million people – more than all the deaths of World War I.

One of the reasons we are here tonight is because of the resurrection of those strains from the Alaskan tundra in a museum jar in the Armed Forces Institute of Pathology. Molecular genetics reconstructed the 1918 virus and revealed it was a strain of bird flu.

Pandemics occur. We would love to be able to know when they will occur, but we don't. As you can see in figure 1, pandemics occur on an irregular basis. Most scientists believe that, sooner or later, a strain that we haven't seen before and that we aren't immune to will be transmitted between people and be carried around the world. Different strains have arisen since the 1918 H1N1 Spanish flu: the Asian flu in 1957, a quite different strain; and the Hong Kong flu in 1968, again a different, or partially different, strain. These represented major shifts in the composition of the virus; and since we hadn't seen them before, we didn't have prior immunity to them. In none of those cases was there, at the time, a vaccine. It has been 28 years since we last faced a pandemic. That's why a lot of

Figure 1: Influenza Pandemics 1700 – Present

Years	Interval	Virus Subtype
1729-30	?	
1732-33	?	
1761-62	18	
1788-89?	6	
1830-31	41-48	
1845	2	
1846-47	1	
1889-90	42-56	H1N1
1889-1900	9	H1N1
1918	18	H1N1 Spanish Flu
1957	39	H2N2 Asian Flu
1968	11	H3N2 Hong Kong Flu
(1977)	9	(H1N1 Russian Flu)
Next	>28	???

Average frequency: 3 – 4/100 years

Adapted from KD Patterson, *Pandemic Influenza, 1700 – 1900* (Rowman & Littlefield, 1986)

people think we can count on a pandemic occurring, and why we ought to be prepared: time is running out.

Until recently, people have largely discounted infectious diseases, with attention going to cancer and to chronic diseases – cardiovascular, diabetes, and neuropsychiatric diseases. The Surgeon General of the United States in 1968 wonderfully exemplified how wrong government officials can be in predicting the future: “We can now close the

It has been 28 years since we last faced a pandemic. That's why a lot of people think we can count on a pandemic occurring, and why we ought to be prepared: time is running out.

book on infectious diseases.” Yogi Berra had it right when he said, “It's tough to make predictions, especially about the future.”

Are emerging infections and epidemics a real threat to the world? Or is it an epidemic of the press? During the last 30 years in the United States, there have been 32 major infectious diseases that had either never existed

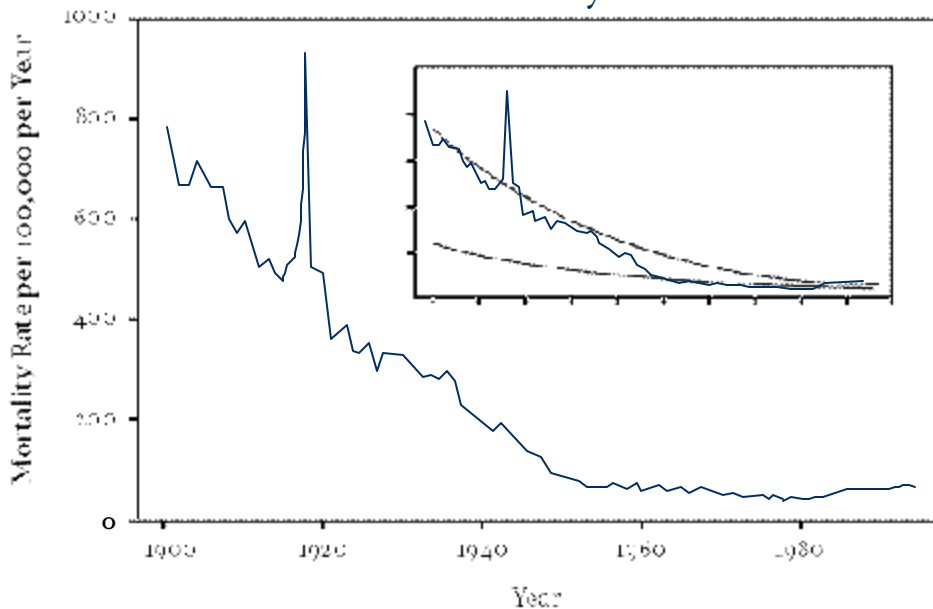
or reemerged (from rotavirus to Legionnaires' disease to lyme disease) and that we didn't know about before 1982: HIV; helicobacter pylori, which causes ulcers; bird flu in 1998; West Nile in New York; anthrax; and SARS are just some better known examples.

Is this a new problem for our era? In order to answer this question, I looked up some past infectious diseases. I saw that pandemics and epidemics have occurred throughout history. Some looked like flu, or conceivably, an early historical precedent for SARS: smallpox, the Black Death, the White Death, the Great Pox, syphilis, the Red Sickness, scarlet fever, jail fever, malaria. So when one asks what is the likelihood that we will face new emerging infectious diseases, the answer is high. We just don't know what and when.

Now let us consider the impact of pandemics on demography by taking the worst-case scenario – the 1918 flu. If we look at the mortality rates for the United States from 1900 to the 1980s, we see a very striking spike during the 1918 – 1919 period, indicating the devastating impact of the flu on survival in the United States (see figure 2). It's clear that these infectious diseases, if we don't deal with them, have tremendous potential to do enormous damage.

The deaths that occur each year from seasonal flu can help us understand the destruction a pandemic could potentially wreak.

Figure 2: Infectious Disease Mortality, United States – 20th Century



Source: Adapted from GL Armstrong, LA Conn, and RW Pinner, "Trends in infectious disease mortality in the United States during the 20th century," JAMA 281 (1) (January 1999): 61–66.

We actually know a lot about seasonal flu and have learned quite a bit from it. One important fact to note about seasonal flu is that it occurs every year – usually in the autumn, shortly after summer. Every year, we can pretty much count on a set of new strains to which we are not fully immune emerging (usually in Asia) and coming to the United States. With few exceptions, a group of reference labs that reports to the World Health Organization has done a marvelous job picking up on the most prevalent strains anticipated to spread around the world. Thanks to their surveillance work and the sophisticated vaccine industry, this country has, within nine months, the vaccines to prevent seasonal flu. Yet, even with good vaccines, 34,000 people in the United States die from influenza. If we can't even protect everyone against seasonal flu, how are we going to deal with a pandemic?

In addition, these numbers do not reflect the deaths that were probably indirectly caused by flu but not scored as influenza-related. It is fascinating that there appears to be a temporal correlation between cases of pneumonia and influenza and deaths from cardiovascular disease and stroke. So the deaths attributable to infectious disease extend beyond those directly caused by the infectious disease itself.

The sheer number of possible fatalities is not the only reason people should be frightened of pandemic flu. Ordinary flu, as you well know, is pretty tough on young children

and the elderly. But when you look at the pandemics of 1918, 1957, etc. – the spike in deaths occurs in young adults, during their most productive years. This is a significant difference between the seasonal flu and a pandemic strain for which we have no prior immunity. The devastation that a pandemic flu can create is clear. But how do new strains of flu arise every year? And how do we think about preparing for them?

Even with good vaccines, 34,000 people in the United States die from influenza. If we can't even protect everyone against seasonal flu, how are we going to deal with a pandemic?

When we say "H₅N₁" and "H₇N₂," the letters indicate the two major outer proteins in the virus, against which we have to develop a good immune response to avoid getting the flu: the "H" refers to the hemagglutinin protein; the "N" refers to neuraminidase. There are at least 15 H's and 9 N's in birds we know about. The flu is also different from many other viruses in that it has not just a single chromosome, but comes in multiple segments, which move around or segregate independently in host cells.

We are very fortunate in the case of H₅N₁ and the avian viruses because these viruses don't easily enter human beings directly. Otherwise, we would have been "done in" when they first emerged a few years ago. In order for them to get into humans, they have to infect an intermediate host, like a pig. Pig viruses do get into humans. If a pig has a bird virus and a human or swine virus, the genes of the different viruses can shuffle, creating a new virus with the virulence genes of the bird virus and the transmission to humans of the swine or human strain. In countries like China, where people live in close contact with chickens and pigs, a perfect cycle can occur – the viruses get from the bird to the pig and from the pig to humans. Thus, new viruses are being made constantly. And when they have an H and an N we've never seen before, we have a scenario for a pandemic.

How do we plan to prevent the spread of bird flu H₅N₁? We know, already, that China has something on the order of 13 to 15 billion chickens. So the idea of running around China, vaccinating every chicken, may not be feasible. Yet this idea of stopping it in its place of origin is a major part of the U.S. strategy. The magnitude of chickens in Asia is not the only problem with this plan. Migrating birds can also carry the virus around the world, disseminating it through droppings or when they drop dead. Ducks – or at least certain kinds of ducks – are also quite dangerous. For reasons not clear to me, they can carry and shed the virus, and not get sick at all – and China has lots of ducks.

Bird flu, mercifully, isn't easily transmitted between humans yet. There are a couple of mutations that would enable facile transmission. There have still been only 174 human cases and 94 deaths. These numbers are quite different from those of the 1918 flu, when the mortality rate was 0.5 percent domestically and 4 percent worldwide. We know that many of the genes that were mutated in the 1918 strain are out there in birds, but not in the same virus. Whether a new pandemic strain will incorporate these genes, or others, remains unclear.

We didn't know until recently how this virus could spread around the world so quickly. Now we know part of the answer lies in migratory bird patterns that are well known to people who study veterinary medicine: the East Asian flyway; the East Africa – West Africa one; the Black Sea – Mediterranean one. The East Atlantic

flyway is of particular interest. It's very likely that if the virus gets past Europe into our hemisphere, it will take this path and this travel is going to be very hard to stop. We

Obviously, the fact that we haven't a clue about what the next pandemic is going to consist of has major implications for preparedness.

may be able to vaccinate chickens in chicken farms, but it's not easy to get your hands on migratory birds.

Where has the virus gone since 2003? It has been found in birds in over 30 countries, and in many of those countries, small numbers of cases have involved direct animal contact. It's all over Asia and Russia and is now moving into Europe. It's also in Africa, which is quite worrisome because the health infrastructures in those countries are not in a position to deal with this crisis. Here, it's important to note that migratory routes are circular. Whatever has moved into Africa or Europe would be predicted to move back into Asia, picking up stuff along the way. These reintroductions, which occur multiple times in multiple places, make the flu difficult to control. We talk about the H5N1 strain because it is spreading in birds, but there are other flu viruses that are also in birds, like H5N2 and H7N2, and have killed or infected people in Canada, New York, the Netherlands, and China.

So if there is a pandemic, we don't know whether it's going to be H5N1 or not. There are flu experts who say that the ubiquity of the H5N1 is such that if it were really going to jump into humans, it would have done so already. They're worried about other strains. Obviously, the fact that we haven't a clue about what the next pandemic is going to consist of has major implications for preparedness. Unfortunately, the United States and most of the world seems to want to combat H5N1 in Asia by getting our hands on all the birds in an infected flock and killing them off. But this strategy will be ineffective, unless we pay a decent compensation to the farmers whose birds are being culled.

Before we can counter an epidemic, we need to characterize how severe it will be. Here,

there are two parameters that really count. One is " R_0 ," the basic reproductive number. This number tells you how many secondary infectious cases derive from a single infectious case. For example, an R_0 of 4 tells you that a single infectious case will infect 4 people. Each of them, in turn, will affect 4 more. Any R_0 greater than 1 means that 1 person is infecting more than 1 other individual and, inevitably, the epidemic will spread. So the challenge of public health is to reduce the R_0 to less than 1.

The second parameter is v , the serial interval, or the time between the development of the first case and a secondary case. The public-health system has to work within this time frame.

What are the R_0 and v for flu? Until Harvard epidemiologist Marc Lipsitch's work, nobody really knew. After all, if you were a really good academic, why would you waste your time trying to model last year's flu, when next year's flu would be different? Because the strains of flu changed every year, no one ever believed that we could generalize a model. In this context, Marc's idea of taking the worst-case scenario was brilliant. Why not model the transmission of the 1918 flu? No epidemiologist had ever done it – so he did it. There were weekly and monthly data showing the number of flu cases in 1918 in fortysome U.S. cities – an extraordinary database from which one can estimate the number of people who died in each of those cities and then model what would happen if a similar pandemic strain got loose.

During the course of the SARS epidemic, Marc and colleagues and a group in London also modeled an infection in real time for the first time in history. They estimated an R_0 of 3 for SARS. Their model told us that by both isolating patients and quarantining those exposed to others with SARS, and with a little luck, we could get an R_0 of less than 1, and the epidemic would disappear. When China finally got its act together to do both, the epidemic went away.

Since SARS had a serial interval somewhere of between 8 and 10 days, there was time to identify people who were sick. In addition, there was no evidence of transmission by people who were infected but appeared healthy; only when they actually showed signs of sickness were they able to transmit.

Now compare the 1918 flu to SARS. I would have guessed that the transmissibility of the

1918 flu, the R_0 , would be far greater than in the case of SARS because the flu killed so many people. In fact, the R_0 was no greater than that of SARS, maybe even a little less. My response: "We didn't really know how serious SARS could have been." But it could also mean, in the case of the bird flu, that if we knew what to do and could do it, we could get an R_0 of less than 1 and eventually squash the epidemic.

But there's a catch. The major difference between the 1918 flu and SARS is not the transmissibility – the R_0 . It's the serial interval v . In the case of the 1918 flu, the v was 2 to 4 days – people were transmitting the flu before they even knew they were sick. So the idea of identifying sick people, isolating them, and quarantining their contacts, as we did with SARS, becomes very difficult.

What would a pandemic, not as bad as the 1918 flu but still pretty bad, look like? According to the U.S. government's projections, 200,000,000 people would be infected, with perhaps 75 million sick, 50 million needing outpatient care, 500,000 needing hospital care that we can't provide, and 100,000 dead. As for the economy, a mild epidemic, according to the Congressional Budget Office, would cost us about \$60 billion. In the worst case, it would impact GDP by \$500 billion.

What can we do? By isolating the infected, quarantining contacts, screening borders, improving hospitals, closing schools and public gatherings, and increasing social distance, we were able to stem SARS. My

Currently, we have good vaccines against regular flu. We need a similar vaccine against bird flu. But how do you make a vaccine against a strain that doesn't yet exist?

sense is that travel restrictions and local quarantine alone are very unlikely to work in the event of a pandemic flu. We will certainly try them, but we know they're likely to fail because of asymptomatic travelers whom we have no way of detecting but who

will inevitably spread the disease. There is the added problem of smuggled birds and pets. With half a million people crossing the U.S. borders every day, it's going to be very tough to keep the virus out of here.

To contain the disease, we have to know, in a crisis, who's sick from bird flu and who has any of a slew of flu-like illnesses.

What about drugs? Can Tamiflu or Zanamivir prevent a pandemic in this country? By reducing viruses and the viral load, they will keep people who have a serious case of the flu from dying. But it is almost inconceivable to me, except under the most favorable conditions, that they could stop an epidemic in one place, not to mention multiple sites simultaneously. We couldn't get them out quickly enough. Since only one company makes Tamiflu, we don't have enough, nor will there be enough, at least in the near future. While drugs are important tools for treating people who do get sick, and can prevent people from dying, I don't see drugs as a way of preventing an epidemic in the United States.

Currently, we have good vaccines against regular flu. We need a similar vaccine against bird flu. But how do you make a vaccine against a strain that doesn't yet exist? And when we do know what that strain is, how do we tool up the vaccine industry so that we can actually produce a vaccine in a timely fashion? Everybody who died in 1919 died in 5 or 6 months. Right now, we can't get a vaccine for seasonal flu in fewer than 9 months. We don't have enough seasonal flu vaccine, let alone the potential to create massive amounts of vaccine against a new strain. And we don't have that potential because there aren't enough fertilized eggs in the world, which we currently use to cultivate vaccines. A big thrust in research is to find an alternative method of growing flu vaccine so that we can produce more vaccine than we are capable of at the moment.

And if we had a vaccine, we would still face significant dilemmas: How much could we

produce? Would we have enough for everybody in the country? If not, what would the market be like for the vaccine? Would only the rich be able to afford it? How would we distribute it?

Today, we only have enough seasonal-flu vaccine for a quarter of the people in the country, and we know from research trials on bird-flu strains that it takes at least four times as much, under present circumstances, to get a comparable immune response. Production will be a problem. Companies won't make this vaccine if they're not given immunity from liability, and that's hard to do unless you guarantee everybody who takes it that they're going to receive indemnity if they experience any adverse effects. We know what the adverse effects are for childhood vaccines, which enables us to have a compensation program based on what we know are appropriate symptoms of adverse effects. But we have no idea what the adverse effects of a bird-flu vaccine are. Finally, even if we had a vaccine, we would have difficulty getting it out there and getting people to take a new strain.

How might a pandemic affect us? Right off the bat, we know that it will make a lot of people sick, disrupt the health-care system, and, if it's really serious, cause a huge number of deaths. It's going to wipe out the travel and hospitality industries. It's going to interfere with business supply and demand, particularly if an industry relies on a just-in-time approach that depends on a steady, balanced flow of materials throughout the production process. If everybody is home sick, you're in trouble. A pandemic will also affect essential services and human resources. It's going to disrupt government; legislatures will not function. Kids will not go to school. There will be public protests. When we obtain vaccines and drugs, they're always going to be scarce, at least the way we're going about it now, and this scarcity will cause nightmarish disputes.

So, what's our strategy? We have a couple of options we can think about now. Clearly, one of them is to reduce the risks through surveillance – get an early warning of what's coming. Right now, surveillance in poor countries is particularly ineffective because we have not provided them with adequate laboratories, training, and research opportunities.

Second, we can try to prevent the spread of disease between animals and humans. Europeans now keep all chickens in houses that have roofs to keep droppings from contaminating them. Otherwise, we don't have many options, except good hygiene – hand washing or even masks.

In the event of an emergency, we also need mechanisms to inform the public truthfully about what we know and don't, and to keep their social distance. Medically, we must stockpile antivirals to keep people from dying, and we must contain the disease to the extent that we can. We can give people some vaccines even now. For many older people, the major consequence of flu is death from pneumonia. We already have very good pneumococcal vaccines, so we can be more effective in preventing this type of death. We could also administer more flu-vaccine strains. If we had a vaccine for a new flu, I would add this fourth strain – an avian strain – to the three seasonal strains we give out every year and start building up immunity to bird strains. Even if it's the wrong strain, it could be helpful.

To contain the disease, we have to know, in a crisis, who's sick from bird flu and who has any of a slew of flu-like illnesses. Currently, Harvard University and most of the hospitals don't have diagnostics. We must develop them if we want to be able to distinguish between seasonal flu and a pandemic strain.

Our highest priority should be to work really hard to get a vaccine against all kinds of strains because one of them may be the right one and it could be too late to develop it once the epidemic is underway.

We must raise "surge" capacity by increasing the number of hospital beds as well as available antivirals and ventilators for people in respiratory distress. Massachusetts has spectacular respiratory surge capacity, but it still doesn't have enough ventilators. Finally, we need people who consider the risks and chal-

allenges of a pandemic, including what to prioritize when resources and knowledge are limited.

Most scientists believe there will be mutations in some bird-flu strain that will enable it to jump between humans. It has happened before. It's just not clear to me whether it's going to be H₅N₁, but we do have time. Developing a strain that picks up all the bad genes from 1918, or its equivalent, in a single virus could take time. However, no one knows where the 1918 flu came from. It did not come from any known source that accumulated bad genes over time. It appeared out of nowhere.

On the systems side, we should recognize that all epidemics, like politics, are local. They may spread globally, but we fight them locally.

The tactics that worked with SARS – like isolation, quarantine, and closing borders – are not going to be particularly serious options for a disease that has a serial interval of two days and a transmission rate even as low as three, nor are drugs likely to prevent the spread of the pandemic. This means our highest priority should be to work really hard to get a vaccine against all kinds of strains because one of them may be the right one and it could be too late to develop it once the epidemic is underway. On the systems side, we should recognize that all epidemics, like politics, are local. They may spread globally, but we fight them locally. Unfortunately, we have degraded our local public-health systems and infrastructure over a long period of time.

Can we prepare? I'm always optimistic. One of the leaders of the Manhattan Project, Leo Szilard, later became a key figure among scientists opposing the use of the A-bomb, and he gave what is my favorite definition of an optimist: "An optimist is someone who believes the future is uncertain."

Howard Koh

In the twenty-first century, some extraordinary public-health challenges have already confronted us. In 2001, the United States experienced bioterrorism and anthrax, which culminated in 22 cases and 5 tragic deaths. Then, the global community suffered through SARS in 2003 – over 8,500 cases; the Indian Ocean tsunami in 2004 – 300,000 dead or missing; and Hurricane Katrina in 2005 – over 1,300 dead. Now, the ongoing threat of pandemic flu is upon us. With all these challenges and many more to come, the question is: how do we build the best public-health system possible, one that will protect all people, all the time?

The World Health Organization (WHO) describes six potential phases for pandemic flu. According to this framework, we are currently in phase three: human infections documented, but no, or rare, instances of human-to-human spread. To date, WHO has confirmed about 175 cases and about 95 deaths worldwide. Everyone fears that we will, at some point, move through phases four and five, and then, ultimately, into phase six – a pandemic period – marked by increased, sustained human transmission.

So, as we live and work in the midst of a pandemic-alert period – phase three – what should be our priorities? I would like to propose five teaching points:

- First, pandemics, and disasters in general, expose global disparities.
- Second, we must create better surge capacity.
- Third, we need ongoing risk communication to rebuild trust in our public-health system.
- Fourth, all preparedness starts locally, so building social capital is essential.
- Fifth, and most important, preparedness means reinvesting in a rejuvenated public-health system.

First, Hurricane Katrina exemplified tragically the fact that pandemics and disasters expose global disparities. Instead of affecting all people equally, Hurricane Katrina exposed disparities in terms of race/ethnicity, socioeconomic status, age, mobility and disability level, and many other dimensions. We witnessed what happens when preparedness does not work: the most vulnerable

are disproportionately affected. In this case, this vulnerable population was overwhelmingly African American, poor and without insurance, and/or without the ability to mobilize and move. We should consider these issues with respect to preparedness for any disaster, particularly pandemic flu.

Why should we be concerned about this disparity? Because in this shrinking world, what happens to some of us concerns and affects all of us. Consider, for instance, the known practice of Asian farmers sleeping with their poultry. Infections in such farmers, a tragedy in and of itself, could potentially ignite disease in broader populations around the world. As the columnist James Carroll has written, "Avian flu makes the point. A disease that incubates among the world's most impoverished people can threaten the most privileged. We humans are all down river from the same coming flood. No one is safe unless everyone is."

Second, we need better surge capacity. The Health Resources Services Administration (HRSA) defines surge capacity as "a health-care system's ability to rapidly expand beyond normal services to meet the increased demand in the event of large-scale public-health emergencies or disasters." In the event of a disaster, are we truly capable of further ramping up our health-care system, which is currently operating at full capacity? We have no choice but to build that capacity to prevent suffering and death from pandemics.

How do we build the best public-health system possible, one that will protect all people, all the time?

We need more space, staff, and supplies. According to the HRSA, communities should aim for an additional 500 hospital beds per million people (urban settings); more decontamination facilities, portable and fixed; more isolation facilities per health-care system; more doctors, nurses, and other allied health-care workers; and more supplies and equipment, such as ventilators and personal protective equipment (PPE).

How does our society build surge capacity for a possible pandemic tomorrow when there are so many pressing medical needs

today? That is a challenge when the health-care system is already at full throttle. In Massachusetts, statewide hospitals have

Pandemics and disasters expose global disparities.

16,500 licensed acute-care beds, but only 13,000 of them are staffed, reflecting ongoing nursing shortages. The state also has about 5,000 ICU beds. In addition, hospital and public-health officials are working diligently to identify level-two and level-three surge-capacity beds. About 4,400 level-two beds could be freed up if hospitals canceled elective surgery and other procedures. Creating level-three beds would require clearing out hospital cafeterias, chapels, and other spaces to allow for patient care. In addition, state and city officials need to identify appropriate community spaces for care, if needed. This occurred in New Orleans during Hurricane Katrina when the Superdome and the Astro-dome were employed.

Mobilizing staff poses yet another challenge. Our state has 29,000 physicians and about 75,000 registered nurses. But an emergency such as pandemic influenza would require many more doctors, nurses, and allied health professionals. Our country is just beginning to address how health volunteers can be readily recruited, mobilized, trained, and deployed in a time of pressing need. The Harvard School of Public Health (HSPH) Center for Public Health Preparedness, like many organizations around the country, is helping to enlist health volunteers in the Medical Reserve Corps, a national effort sponsored by the U.S. Surgeon General. In collaboration with the Boston Public Health Commission, we are actively encouraging available health professionals to volunteer and receive online training in preparation for a disaster. In addition, all countries are mobilizing supplies such as antiviral agents. All these efforts are integral to increasing surge capacity to protect people in a time of need.

Third, we must improve risk communication to rebuild public trust. As the Massachusetts Commissioner of Public Health during the anthrax crisis of 2001, I was charged with delivering risk communication through daily press conferences with the Governor, the Secretary of Health and Human Services,

the Secretary of Public Safety, FBI officials, and U.S. Postal Service leaders. Our common mission was to keep the public informed through a very uncertain time and coordinate protection for all 6.5 million people in this Commonwealth.

Now, recent public-health events have again underscored the critical importance of high-level risk communication. One prominent example centers on the challenges our country has faced in distributing seasonal flu vaccine. Last year, during the 2004–2005 season, an England-based Chiron facility shut down and ceased flu-vaccine production. As a result, Sanofi Pasteur was left as the sole producer of the national flu vaccine—about 61 million doses that year. This overall shortage forced the Centers for Disease Control and Prevention (CDC) to promulgate priority groups of those who should be vaccinated ahead of the general population. Those prioritized included people over 65 years of age, young children aged 6–23 months, and people with chronic health conditions.

In the aftermath of that flu season, Cait DesRoches and Robert Blendon from the Harvard School of Public Health polled over 1,200 adults in the United States and asked, “Were you confident in the fair distribution of the 2004 flu vaccine?” About 60 percent of respondents replied, “Yes, we are somewhat (or very) confident.” But about 40 percent said, “No, we’re not very confident (or not confident at all) in this triage process.” In a similar survey, recently published in *Health Affairs* by Professor Blendon and his colleagues, people in four countries were asked, “Do you trust government public-health authorities as a source of useful and accurate information about an outbreak?” In Taiwan, Hong Kong, and Singapore, over 50 percent of the people responded affirmatively (“Yes, we trust government public-health authorities a lot”) while in the United States only 40 percent responded similarly.

So in the event of a pandemic, when government public-health authorities propose priority groups for vaccine prophylaxis or social-distancing measures, will the American public comply? During SARS, officials in Toronto quarantined 23,000 people, all but 27 voluntarily. To assure such levels of public cooperation in the event of a crisis, officials need to be afforded the highest levels of trust. This theme is particularly important at the local

community level. In his fascinating book, *Bowling Alone*, Harvard professor and world-renowned author, Robert Putnam, argues that the cohesion of the American community has declined dramatically to the point that we don’t know our neighbors and don’t invest in building social capital as we did in the past. The threat of a pandemic offers an opportunity to reinvest in our communities, rebuild trust, and create better social networks so that no one is “bowling alone.”

On the local level, hospitals and medical professionals are wrestling with the issue of how to define appropriate standards of care in a crisis. In our society, we expect unlimited medical resources to be made available for our loved ones in a time of need. In a time of mass casualties, however, society may need to employ the public-health ethic of the greatest good for the greatest number. What’s an acceptable standard of care in such an instance?

Meanwhile, hospitals are not the only institutions that need to plan ahead. Businesses should have continuity-of-operations plans, beginning with the assumption that up to 40 percent of their workers may be out sick. Schools and religious organizations also need to plan as well.

How does our society build surge capacity for a possible pandemic tomorrow when there are so many pressing medical needs today?

Planning can be enhanced by working at the regional level. This can be challenging in states such as Massachusetts, where there are 351 cities and towns but no county or regional form of public-health structure. With the recent infusion of federal preparedness-related funds, many states have emphasized the public-health opportunity offered by regional planning. For example, fire departments have long benefited from mutual-aid agreements. In the event of a major fire in one town, colleagues from neighboring cities and towns in the region can join in to help. For public-health officials in cities and

towns, such agreements are still in a state of evolution. Regional planning can offer an efficient way for adjoining hospitals, emergency-medical services, and public-safety

We must improve risk communication to rebuild public trust.

organizations to build a common web of protection. Each community and region must know how to report cases to state and federal authorities; administer prophylaxis or vaccines on a community-wide basis; obtain more personal protective equipment for community members; and effectively communicate information in a timely and transparent manner that builds trust.

Preparedness is not simply a theoretical issue but rather an area of concrete implementation and practice. As part of our educational mission, therefore, the HSPH Center for Public Health Preparedness has

emphasized drills and exercises as a highly effective means of role-based training. In such simulations, gathered leaders from local government, the community, schools, and indeed all sectors of society are asked to respond to an unfolding set of pandemic scenarios. Many concrete issues immediately arise. If an outbreak occurred at a university, for example, what would be the appropriate trigger to administer prophylaxis, institute social-distancing measures (if possible), cancel classes, or send students home? And what would be the most effective and appropriate risk communication messages to students, faculty, and families? This hands-on method of teaching people highlights the importance of unified command and understanding roles and responsibilities – all in a safe environment.

In these exercises, we pose some very basic questions to assess readiness, such as: Does your business have an emergency plan of operation? Who would be in charge? Do you know your role within an emergency plan? Whom will you contact or who should

be contacting you? Does your family have an emergency plan? Do you have backup food and medical supplies for your family? Such burning questions haunted us during Hurricane Katrina and will undoubtedly arise again in any emergency.

Finally, preparedness represents an opportunity to reinvest in a rejuvenated public-health system. The media has focused much attention on the need for better vaccines and an antiviral supply. In addition to more shots and pills, however, we also need a comprehensive system that works efficiently and effectively to protect all people. Public health protects every life and, indeed, every day of every life. Public health adds years to all of our lives and quality of life to all of our years. If we maximize this crucial opportunity to promote public health – what it is, why it's important – then we will all enjoy the promise of a healthier future. ■

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Barry R. Bloom (Harvard School of Public Health), Howard Koh (Harvard School of Public Health), and Joseph Boyd Martin (Harvard Medical School)



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Innovation: The Creative Blending of Art and Science

Featured Speaker: George Lucas; Remarks: Rob Coleman; Discussant: John Hennessy

Introduction: Warren Hellman

This presentation was given at the 1900th Stated Meeting, held at the Letterman Digital Arts Center in the Presidio of San Francisco on March 18, 2006.

George Lucas is Chairman of Lucasfilm, Ltd. He has been a Fellow of the American Academy since 2000.

Rob Coleman is Animation Director of Lucasfilm Animation.

Warren Hellman is Cofounder and Chairman of Hellman & Friedman LLC. He has been a Fellow of the American Academy since 2005.

John Hennessy is President of Stanford University. He has been a Fellow of the American Academy since 1995.

Warren Hellman

As a recently elected Fellow, I recognize that while the Academy draws inspiration from the past, it is always focused on the future. The place where we are meeting tonight, like the city that surrounds us, certainly inspires thinking about the future. On behalf of everyone at the Academy, we are honored to be here tonight. Thank you, George, for opening your new home to us.

I know that we all arrived at the same entrance and got to experience a tiny taste of the wonderful design, one-of-a-kind artifacts, and lovely architecture of this place. But what we've seen barely scratches the surface of what's here at this campus. For those of us who live in San Francisco, we remember well that the Digital Arts Center sits on 23 acres of a national park: the Presidio of San Francisco. An asphalt parking lot and a closed and crumbling Army hospital used to sit on this site. Now it consists of 17 acres of park space open to the public 365 days a year, a café overlooking the Palace of Fine Arts, and 5 acres of some of the most sophisticated, technologically advanced buildings for the employees of Lucasfilm, Industrial Light & Magic, and LucasArts. It has already become a landmark.

But it's not just a pretty place. One of George's primary goals in the building of this campus was to put a stake in the ground for the future of the digital arts and to foster the next generation of creative minds. With the state-of-the-art technology that drives this place, the thirty-year legacy of the Lucas compa-

nies, and the visionary leadership that George has exhibited his entire career, I know we can count on achieving that goal.

On behalf of the Academy, I want to say how pleased we are to be here tonight and have George Lucas as our featured speaker. As we celebrate our 225th anniversary, no one could better exemplify the American Academy's ideals. Elected in 2000 to the Academy, George has pushed the known boundaries of science and technology. He started the digital revolution in the late seventies, and continues to lead the charge today. He is one of cinema's most influential and successful directors and producers. His films, including *American Graffiti*, *Willow*, the *Indiana Jones* series, and the *Star Wars* saga, have delighted audiences for years.

As one of the directors of Twentieth Century Fox, the company that produced the first *Star Wars*, I witnessed the beginning of *Star Wars*. I recall the screening Fox held for the directors. There were eleven of us, and we were each handed a ballot. At the time, Twentieth Century Fox was in dire financial

straits. The ballot had three boxes: 1) “This will be a breakout film”; 2) “We may get our money back”; and 3) “We’re going to lose all our money.” The film obviously turned the studio around. It and its successors were the most profitable movies ever made in the history of Hollywood.

Recently, the President presented George with a National Medal of Technology for thirty years of groundbreaking work at Industrial Light & Magic. ILM has pioneered the dazzling visual effects that have become the signature of such filmmakers as Steven Spielberg, James Cameron, and Robert Zemeckis.

George is also deeply committed to education. The George Lucas Educational Foundation focuses on school-community partnerships, project-based learning, technology, and intertechnology integration. It also provides through its website a multimedia resource center for educators.

The format for tonight’s program will include remarks by George, during which he will invite one of the key collaborators at Lucasfilm to join him for some demonstrations. After that, President John Hennessy of Stanford, himself a distinguished innovator in computer technology, will join in a conversation with George.

George Lucas

It’s a pleasure to host this West Coast meeting of the American Academy.

I’m going to begin with a few remarks on art, because there always seems to be this dichotomy between science and the arts. I don’t really see that dichotomy because I work in both fields. From my point of view, technology and art have always gone hand-in-hand.

Art, at least in my definition, is one way of communicating emotions, things we can’t directly communicate in other ways, whether through mathematics, an essay, a technical drawing, or a blueprint. Art conveys beauty, which appears in nature and which science is still trying to figure out. No other animal has, at least consciously, our ability to create beauty, to stir the same emotion in a human being that a rose might inspire.

People say, “Oh, you work in the high-tech end of movies, and movies are so technical.” But art has always been technical. One characteristic of human beings is to be able to

Art is one way of communicating emotions . . . ; it conveys beauty, which appears in nature and which science is still trying to figure out.

transform and to use devices according to our will; one of the first events that separated us from apes, I think, was when man picked up a piece of charcoal and started drawing on a wall. This technology, drawing on a wall, was followed by the technology of drawing in color – figuring out how to get colors and where to put them. And the struggle to improve art-making technology has continued since.

Every time we have had a technological development in the arts, we have been able to express ourselves with more freedom. Consider, for example, in music, the discovery and development of instruments; or, in theater, the development of the proscenium (one of the biggest problems Shakespeare had was getting people on and off stages). Likewise, the technologies of writing and the printing press allowed a writer to gain a larger audience and to move the art of writing forward.

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So, to me, art and science are very closely linked. Science gives us the “how,” and art gives us the “why.” At the last Academy meeting I attended in Boston, the discussion was, is there hope for the humanities. I believe there is. I’ve been very involved in education, and one of the main parts of the educational program today is math and science,

which are obviously extremely important. But those really are the “hows”; the humanities show us the “whys.” It’s one thing to build a bomb; it’s another thing to know when to use it and why. Of course, the “whys” have a tendency to get pushed aside. For those of us in the humanities, we would like to see the humanities catch up with science and technology so that we can have a better sense of why we’re learning how.

With that, let me introduce one of our key animators, the man behind Yoda.

Everybody talks about the art of acting, and whether or not digital technology will ever replace the actor. That’s not going to happen. With a character like Yoda, you have an extremely talented actor in Frank Oz, who does the voice and acts in front of a video camera. But then you also have another group of artists – the animators – who take that acting and make it into an actual character. Animation is a whole art, a field that is half acting, half art. So, in a way, a digital character takes five or six people, instead of just one, to make – which means it costs five to six times more to make a digital character than to hire the Brad Pitts of the world. So I don’t think digital characters are ever going to replace human beings because human beings are unique; they’re crazy, and it’s going to be a long time before computers get crazy in that interesting, rather than frustrating, way. Now, here is my good friend and the head of our animation department, Rob Coleman, to explain animation a bit.

Rob Coleman

I remember looking at some early footage of George talking about the decision to have Yoda as a character in the movie. I’m paraphrasing here, but I recall him saying: “If he’d looked like a silly Muppet, then the whole experience would have been a disaster.” Of course, it wasn’t a disaster. We all fell in love with this wise old sage, and we completely believed his interaction with Skywalker.

I’ve had the opportunity and the honor to work with George since 1993. In 1995 George came to Industrial Light & Magic and said we were ready to open up the *Star Wars* trilogies again. It’s been a privilege to be able to take characters as important as Yoda and bring them into the digital age. I knew from

the beginning how special this character was, and I didn't want to be known as the guy who wrecked Yoda. So I studied frame-by-frame the footage George had done with his earlier collaborators, trying to distill the essence of Yoda. Who was he? How could I breathe a little bit of my humanity into this new digital character?

It's been a privilege to be able to take characters as important as Yoda and bring them into the digital age.

I want to take you through some of the techniques we used in those early days to illustrate how we've stood on the shoulders of the people who came before us, and how we use computer technology to serve the story and our filmmaker.

I'll start with Yoda. Behind Yoda – and George alluded to this – are character designers; sculptors; painters; computer modelers; specialists who put the bones into the characters; animators; clothing specialists (of course, all the clothing is digital); lighting technical directors, who make sure the light looks real; composers who blend the digital character into the live action; and visual-effects supervisors, who collaborate with George on a daily basis.

We've been working on creating an animated character for a long time. The biggest challenge, of course, is blending our character into the scenes with live actors. Our audiences judge the realism of a film on a moment-by-moment basis. They know what cloth looks like when you tumble on the ground. So, because this is completely fabricated inside the computer, a lot of very talented people must figure out how to make fabric look real, how to incorporate the subtlety of the motion of our little hero sliding on the ground.

For my team, it starts with video reference. The idea here is to key in on what is subtle and what is realistic movement. So we study ourselves a lot. All of the animators have mirrors at their desks; we videotape ourselves; and we study our images.

As an attempt to help a key animator work out a scene in the movie, I once hung off the stairwell at ILM. By looking at the strain in my own face – and I was hanging about a foot off the ground – we were able to make Yoda's action more subtle than it was when we started animating.

A character will go through various stages, getting rough lighting and cloth on it, until we achieve the final image. George works up at Skywalker Ranch with the layout team, which roughly places the character in the scene. We're not looking at or judging performance at this place, just composition and timing. My crew then gets involved and starts adding in the performance, the acting. This is what we call CARI (the ILM facial animation software) render. The color is only there to help us see the movement of the skin; in no way do we deem it realistic. Not until the technical directors and compositors get involved do we start to see a realistic image, one that will make the audiences say, "Yes, that's alive. That's real."

In certain sequences in the movie, some of our actors – like Samuel L. Jackson – need to be digital doubles. ILM has been pioneering a technique to generate models that use ten digital cameras, which are slaved to the exact same nanosecond and surround a live person.

We have to do this because some of our key actors – Ian McDiarmid, for example – are not swordsmen, which may or may not surprise you. We actually do a shot with a stuntman made up to look as much like Ian as possible. We don't really worry about the facial structure, of course, because we have Ian and Ian plays a double role. We use laser technology that scans the entire head and compiles a volume of images inside the computer, which our digital modelers use to create a digital version of Ian McDiarmid.

Our painters and match-movers then get involved. The first thing they do is track where the head was. The blue lines tell us whether our virtual camera – our computer camera – is locked into the real camera that Lucas used on the day we shot. Our painters then get rid of our poor stuntman's head, painting it frame-by-frame. My crew gets involved at the same time, animating a performance by using the stuntman's actual expressions as a guide. We move the digital face so that it is emoting. Finally, the compositors get involved and blend them together.

This may come as a surprise: Christopher Lee can't actually jump off a ledge. Initially, we wanted Count Dooku to levitate and come over. But George said, "No. He doesn't fly. He's got to jump." So I went back and had the animator draw the character jumping. And George said, "Come on! It's got to be more active than that!" So we tried something else. He said, "No, no. You don't understand. He's got to flip. He's got to jump." So I showed him another variation, and this time he said, "That's good."

George and I were sitting in a room with about ten other people as we reviewed the animation. George was happy. But when I left the room, the clothing specialist immediately grabbed me and said: "No, no! You don't understand! We've been doing tests! There's no way we can do that shot! Look! This is all we're getting!"

Although our work is an art and a science, there's also some magic involved. After a little bit of time – and we never fully tell George how long we're at the computers late at night – we were able to work it out and to show him the "red" version – revealing how our digital cloth is interacting – and then the final image.

I can recall other times when we didn't think we were going to need a digital character until we got into the editing room and George started cutting the sequence together. When he came to a point where he wanted a high-angle shot looking down at two Jedi with their swords locked, he found that he didn't actually have that footage. So he came to me, and we talked about whether my department could handle creating digital characters. I said, yes, of course we could. Because we are

The biggest challenge, of course, is blending our character into the scenes with live actors.

going to undercut the digital characters with the real actors, we have to match our cloth to the costumes the real actors are wearing – so the clothing team gets involved. In the end, we have an image that's cut into the sequence, and the audience can't tell those aren't real people.

We can also use digital technology with real characters, not just with digital characters. In this example, we only had five Wookiees – Chewbacca is a Wookiee. We take an old idea: put the five Wookiees in front of the camera, shoot some footage, then move

A character will go through various stages, getting rough lighting and cloth on it, until we achieve the final image.

them and give them different weapons. Shoot them again and again, until you have a number of passes that can then be combined in the compositing. We knew that we could only do so many passes, and we also knew that George wanted lots of characters. So we started to create digital Wookiees and placed them in the background.

Meanwhile, my friends on the visual-effects side created a miniature beach and a miniature wall, both of which are matched to the real camera. The people responsible for figuring out how digital fur works then applied “motion capture” – in which the cameras capture an actor in motion – to a digital character. The result is some digital jumping jacks checking digital fur. Then we create a chorus line in which we change the mapping or the color of the fur to create one model, or a lot of different Wookiees that are then blended together. The result is two rows of real Wookiees combined with digital Wookiees running out to battle.

One of the joys of being in the animation group was creating the new villain for the latest movie: General Grievous. Grievous was fully animated, and like all the other characters I’ve been showing, he had digital cloth. When trying to create a character, I always like to start with some kind of touchstone. In the early days of developing Grievous from the animation side, we were actually inspired by Willem Dafoe’s portrayal of Nosferatu. For a period of time, Grievous was going to be more vampire-like; he ended up sort of sickly and with a cough. I really liked Dafoe’s performance, so I actually had one of the animators do an early test using it to get all those high-frequency actions that later became part of Grievous’s library.

As well as studying humans, we also observe the animal world. In the latest movie, we have this running, galloping lizard, which I was very worried about initially. But a couple of friends in the art department said, “We were watching the Discovery Channel, and there’s this crocodile that runs! You’ve got to see this!” I had no idea crocodiles ran. But as an animator, I was fascinated by the footage and studied it carefully. Eventually, we used it as the starting point to envision how our lizard was going to run and jump.

I’m giving you all my secrets, ones that I haven’t even shared with George before.

The last tool that I’ll tell you about tonight is motion capture, which I referred to earlier. First, you put an actor in a special suit in a special room. Cameras surround the room; the suit itself has markers on it. The cameras can triangulate where an elbow or a knee is. We then take that real movement – in this case, a retired Navy Seal – and apply it to the character to get realistic motion. Prior to Episode III, a bunch of overweight animators and I were running around being clones, and George pointed out – rather correctly – that the clones were not quite as aggressive as he’d originally planned. I took that to heart and now we have our Navy Seal taking out our crowd of droids – a marked improvement over Episode II.

I hope this has been an entertaining perspective on our world.

Conversation with John Hennessy and George Lucas

John Hennessy: George, you said earlier that you don’t see a separation between the technology and the creative storytelling. But, certainly, when you imagine something, and I am thinking back to those early *Star Wars* movies, whether it was the light saber or that memorable image from the very beginning of *Star Wars*, how do you contemplate what might be possible with the special effects when they become such a key part of the storytelling? What comes first here?

George Lucas: It’s always the story that comes first, but the technology also determines the story. It has always been that way with art, especially in the more physical art of painting, where the idea of developing color was a major part of art for a long time.

The person who could create the best colors, who had that technology, could do the most beautiful work – in theory.

Film is the most technological of all our art forms. In contrast, with literature, a writer can bring about a psychological experience using just words. After reading the words, a reader translates them into mental images. In movies, it’s tougher because we actually have to make viewers believe for a brief second – twenty-four frames – that what they are watching is real. We have to physically make something. We can’t just write the words down as we do in a script and say, “This is it.”

Having gone to film school, studied film, and learned how all the various pieces of film go together, I knew the story I wrote could only go so far in conveying what I was imagining when I started *Star Wars*. I knew I was playing with fire because science fiction and fantasy are basically literary genres. They aren’t really cinematic because it’s impossible to recreate in real life what we can imagine. That’s the whole magic of it. That’s why science fiction and fantasy are such wonderful literary mediums: we can go to places we can’t go to in reality. But in film, we’re stuck.

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Also, when I wrote those scripts, I didn’t have much money. For all artists, available resources are an issue, whether you’re Michelangelo or you’re working in a cave.

The amount of resources limits your imagination. With film, I knew how I could do everything. I wasn't pushing the envelope too far. But even though I basically had Episodes I, II, and III in mind (they were written first, as the back story), I knew I

In motion pictures, we have to figure out the technology in order to let our imagination roam freely. The greatest thing about digital technology is that it really does enable cinematic artists, those who work in the moving image, to imagine anything they want.

couldn't film them. I couldn't actually go to the city-planet Courasant. The number of aliens that all those worlds required made it impossible to film back then.

So I started with an episode that was very confined: it takes place on a desert planet, a Death Star. I had to cope with only one technology: panning with spaceships. It seems like a very simple thing to do. Stanley Kubrick did the most monumental and technically most advanced science-fiction film with *2001*, but his camera had to stay static because of the matte paintings, and he had to make many passes because his cameras had to match up perfectly. So the shots were all very slow. They're very realistic, and they show how boring space really is.

I wanted to show how exciting space could be, but this world isn't real – it's imaginary. I wanted to be able to move the camera, do short shots with ships flying around, and shoot dogfights – things that we just couldn't do then. So I set my sights on solving that technological problem and found the solution by combining computers with cameras. Ultimately, it involved taking an animation camera, turning it, and, instead of shooting pictures, shooting models. In the second film, I had another challenge: how

do you make a two-foot green guy believable? I could barely make him move because he's obviously a man's hand. So the whole thing was shot in close-up. We did one shot of a midget in a Yoda suit with trick photography to make him look small.

Those technological ceilings determined how much I could imagine. I was extremely frustrated as an artist because I had this idea of a much bigger world and many more fun things, but I was very, very limited. This happens with a lot of art unless you sit down and say, "I'm going to figure out a different way of doing this." Think about Leonardo da Vinci trying to cast the largest bronze horse ever created. Even artists back then had to solve technological puzzles such as how to set a five-ton globe on top of a chapel.

And we're still in that business. In motion pictures, we have to figure out the technology in order to let our imagination roam freely. The greatest thing about digital technology is that it really does enable cinematic artists, those who work in the moving image, to imagine anything they want. Before *Star Wars*, resources in the movie business were dwindling because of television; and, of course, people were getting paid more, so we couldn't have thousands of extras in epic movies. The films of the 1950s and 1960s were mostly street films and psychological thrillers – very small in scope – with a few Westerns thrown in here and there. Film-makers couldn't think of doing another *Cleopatra* because, basically, the epic genre was dying. But once digital technology came around, suddenly epics were available. We could do *Gladiator*. We could make giant World War II movies. We could do almost anything we dreamed.

Hennessy : I'm dying to ask whether your imagination has ever outstripped the technology. What would you have done if Yoda hadn't looked real, or the Death Star hadn't looked like the really terrifying thing it was?

Lucas : This place wouldn't be here. I wouldn't be here.

Hennessy : But did you ever encounter a circumstance where you had to rewrite the story to live within the domain of the technology?

Lucas : The first three *Star Wars* were written within the domain of the technology. I would take a chance with one technological leap. In the first one, it was panning with spaceships;

in the second, it was creating a realistic green Muppet.

Hennessy : Jabba the Hutt?

Lucas : Yes, Jabba the Hutt was a lot easier in a way because he kind of just rolled around. By that time, the technology that we had developed for Yoda could be used for other people. For Yoda, I had Jim Henson, the most brilliant puppeteer ever, and Frank Oz, who worked very closely with him. We all worked together with Stuart Freeborn and a whole lot of people to develop the technology to make Yoda look real. Most of the realism – to be very honest with you – in the first three movies is Frank Oz. Puppeteering is an art form; it's acting to make a little sock on your hand look like a real character and Frank is brilliant at it. Now, Frank bows to Rob, which embarrasses Rob. Frank says, "Gosh, I don't have to sit there with my arm up; it doesn't hurt anymore. And I look better than ever!"

No matter what movie we're working on – especially in terms of special effects – we're pushing the envelope. We're doing things that have never been done before, and people depend on us to make it seem real. If we failed, we would eventually go out of business. But I don't think we've ever really failed. We may have had a few shots here

No matter what movie we're working on – especially in terms of special effects – we're pushing the envelope. We're doing things that have never been done before, and people depend on us to make it seem real.

and there that aren't quite as good as they should be, but we've always managed to keep the illusion going. That success owes as much to engineering and science as to the creative arts of painting, sculpture, etc. Creating an illusion and telling a story really requires collaboration between artists and scientists.

Hennessy: Rob mentioned motion capture. I found that interesting because when you use motion capture, you're basically imitating human motion; otherwise, it's hard to make it look natural without a lot of work. What is it that makes motion capture such a useful technology?

Lucas: Let's face it: artists aren't a dime a dozen. Nowadays, we need a lot of animators, and a really brilliant animator, given enough time and money, could create a perfect movement by drawing every little movement, as animators did with Bugs Bunny and Daffy Duck. Of course, they were drawn in such a way that the animators didn't have to deal with detail.

But when we start animating human motion, it requires an entirely different level of animator. Motion capture enables us to do a lot of the hard work of capturing the detail that an animator may or may not remember. *Polar Express* was done with motion capture, which sped things along. With motion capture, the animator can focus on the acting, the emotion, rather than the details like what the hair is doing back there or how the ear is moving.

Hennessy: What do you see on the horizon in terms of technology that might take movie making and storytelling to the next step?

Lucas: I think we've made that leap. We made it when we developed digital technology, which was accomplished over a long period. The real breakthrough was *Jurassic Park*, where we took a completely animated character and made it look completely real. The best example now is the old *King Kong*, where we know King Kong is a little puppet moving around – that was the first time that kind of art was done – to the new *King Kong*, which is just amazing to watch. It's hard to believe that's a computer character. That level of detail, emotion, and sensitivity in a basically unreal character has pushed up the level of filmmaking very far.

Hennessy: I grew up in New York, and, as a kid, I remember going to the Museum of National History and seeing the dinosaurs in those fake poses, never moving. I'll never forget that opening scene in *Jurassic Park* when we see a dinosaur actually move.

Lucas: This is how it came about. Dennis Muren, our special-effects guru, has been with me since the beginning of the company. Steve Spielberg was doing this movie,

as well as Phil Tippett, the world's premier stop-motion animator, who also works for us. Stop-motion animation is a very esoteric art form, and they were just going to do the dinosaurs in stop motion, as usual. But Dennis said, "You know, I think maybe we can do these digitally now." And so we got together, and Steve said, "Well, I'll look at something if you do it." I said, "We'll finance it on our own to see if we can accomplish this." When that first test came up in the screening room, people were crying, especially Phil Tippett. It was a milestone. I shoot my films digitally, manipulate them digitally, and show them digitally. That is the big technological change – the sound of our era. It happened quite a while ago. Computers were created a while ago too, but the film industry hasn't caught up yet; we're the only ones who are using this technology.

Digital helps the artist by allowing him to change his mind, manipulate his images, and do things so that they're not fixed.

We've been making digital films in San Francisco for ten years; they still don't make them in Los Angeles. One of the reasons I wanted this digital center was to say, "Hey, this is where everything started. This is where this whole art form began." It is a step up from the photochemical process. Those are our roots, but we're in another era now.

Hennessy: We hear a lot of talk about how technology and the creative arts cannot fuse, yet you can't make your movies unless you can fuse the two and unless you can build working teams with people who come from very different backgrounds and think very differently. Do you find that's a challenge? Or does the story inspire everybody?

Lucas: Working with people to move an artistic vision forward has always been a challenge. Leonardo da Vinci is the perfect example of a scientist/artist who had to work with a lot of people. Painting a fresco was hard work. You had various people involved: "Here is the guy who does blue; it's the best blue in all of Italy. Here's the guy who does green, and here's the guy who does the plaster. I have to do this one piece before it dries, and then we have to match it and move on."

In addition to making it unbelievably beautiful, da Vinci had to deal with all this technology. He had to build scaffolding, and someone had to bring the stuff up and make sure it didn't dry.

Filmmaking used to be like that. Because we used a lot of people, we couldn't change anything once we did it. But with digital, it's almost as if we invented oil painting. Suddenly, if we don't like what we've painted, we can paint over it, get the light just right, etc. And I can catch it while I'm making it. Digital gives us the same freedom that oil painting gave artists, especially in the Impressionist movement, to go outside and see the way light played on things. They could stand there and watch it while they were painting. Before, they were trapped in a chapel or art studio somewhere. Digital helps the artist by allowing him to change his mind, manipulate his images, and do things so that they're not fixed. There's no longer a giant crew sitting there, waiting, at the expense of some ungodly amount of money; the Pope coming in every five seconds saying, "Get it done, Guido. We've got a release date. The studio's going to go bankrupt!"; the board saying, "When are you guys going to get this thing done?"; and the artist saying, "Well, my God! I'm going as fast as I can! I'm doing this, but it's hard! I don't have the tools, really, to make this work."

That's the wonder of technology, because, in a lot of cases, an artist's creativity is self-limiting. If it's absolutely impossible, the artist doesn't even attempt it because why would you? But the more possibilities technology breaks open, the more we can think, "Oh, we could do this, and we could do that." We start imagining bigger pictures.

Hennessy: When you think about your films, how do you think about this whole issue of timelessness? If you look at the Sistine Chapel, or at Michelangelo's *David*, or at Brunelleschi's Dome in Florence, they have a sort of timelessness to them. You see them even today, hundreds of years later, and you recognize they are aesthetically just incredible. How do you think about that in film, where the media is constantly changing and improving?

Lucas: Ultimately, all art is a product of its time. Most art up to the modern day was illustrative. You were hired by somebody to tell a story, to bring out the emotion, even if it was simply a portrait like the photographs

we have now. Every time I look at a photograph of my kids, I say, "Aww." The same idea applied back then. If I wanted a portrait of my wife, I would hire you to paint her portrait. Or the Church, the largest corporation of the day, would hire you, saying, "We want to experience God."

Anybody who knows a lot about art can look at a painting from that period and recognize

it as from that time. It's the same with film. You can look at a film now and say, "Oh, that was done in the thirties. That was done in the Golden Age."

The age we're now in is postmodern. I was shocked when I heard that. But I guess we are the first age of cinema to actually have studied cinema. Before, filmmakers studied literature. But just as Michelangelo studied

the Greeks, we're now able to study John Ford and the great directors of the thirties and forties. ■

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John Hennessy (Stanford University) and George Lucas (Lucasfilm Ltd.)



Warren Hellman (Hellman & Friedman LLC) and George Lucas



Rob Coleman (Lucasfilm Animation)



Walter B. Hewlett (William and Flora Hewlett Foundation) and Leslie Berlowitz



Robert Birgeneau (University of California, Berkeley) and Randy Schekman (University of California, Berkeley)



Louis Cabot (Cabot-Wellington, LLC), Peter Bing (Los Angeles, CA), and Jesse Choper (University of California, Berkeley)

Noteworthy

Select Prizes and Awards

Seymour Benzer (California Institute of Technology) was awarded the Albany Medical Center Prize in Medicine and Biomedical Research.

E. L. Doctorow (New York University) was awarded the 2006 Michael Shaara Prize for Excellence in Civil War Fiction for *The March*.

M. Judah Folkman (Harvard Medical School) was awarded the Warren Alpert Foundation Prize.

Carol Gluck (Columbia University) was awarded The Order of the Rising Sun, Gold Rays with Neck Ribbon by the Japanese government.

Linda Greenhouse (*New York Times*) was awarded the 2006 Radcliffe Institute Medal.

Don Harran (Hebrew University of Jerusalem) has been made Knight of the Order of the Star of Italian Solidarity (Cavaliere dell'Ordine della Stella della Solidarietà Italiana).

Geoffrey Hartman (Yale University) received the 2006 Truman Capote Award for Literary Criticism for *The Geoffrey Hartman Reader*.

Alan Hastings (University of California, Davis) received the 2006 Robert H. MacArthur Award from the Ecological Society of America.

John G. Hildebrand (University of Arizona) is the recipient of the Outstanding Service Award, given by the American Institute of Biological Sciences.

Thomas Kailath (Stanford University) was awarded the Jack S. Kilby Signal Processing Medal by the Institute of Electrical and Electronics Engineers.

Daniel E. Koshland, Jr. (University of California, Berkeley) is the recipient of the 2006 Welch

Award in Chemistry, given by the Welch Foundation.

Benoit Mandelbrot (Yale University) has been promoted to the rank of Officer of the Légion d'Honneur.

Claire Max (University of California, Santa Cruz) is the recipient of the 2006 Chabot Science Award, given by the Chabot Space and Science Center.

James D. Meindl (Georgia Institute of Technology) was awarded the 2006 IEEE Medal of Honor by the Institute of Electrical and Electronics Engineers.

John Meurig Thomas (University of Cambridge) has been awarded the Sir George Stokes Gold Medal of the Royal Society of Chemistry.

Ellen S. Vitetta (University of Texas Southwestern Medical Center) has been named to the Texas Women's Hall of Fame.

Marvalee Wake (University of California, Berkeley) is the recipient of the Past President's Award, given by the American Institute of Biological Sciences.

George M. Whitesides (Harvard University) was awarded the 2007 Priestley Medal by the American Chemical Society.

Frederick Wiseman (Zipporah Films) was awarded the 2006 George Polk Career Award and the 2006 American Society of Cinematographers Distinguished Achievement Award.

New Appointments

Mildred S. Dresselhaus (MIT) has joined the Scientific Advisory Board of Nextreme Thermal Solutions.

Larry R. Faulkner (University of Texas at Austin) has been named Chairman of the National Math Panel by the Bush administration.

Frances Daly Fergusson (Vassar College) has been appointed to the Board of Directors of Mattel.

Alice P. Gast (MIT) has been appointed President of Lehigh University.

James D. Meindl (Georgia Institute of Technology) has been named Director of Georgia Institute of Technology's Nanotechnology Research Center.

Ira M. Millstein (Weil, Gotshal & Manges, LLP) has been named Director of the Yale Center for Corporate Governance and Performance.

Jessie Ann Owens (Brandeis University) has been named Dean of Humanities, Arts and Cultural Studies at the University of California, Davis.

Select Publications

Poetry

Charles Bernstein (University of Pennsylvania). *Girly Man*. University of Chicago Press, September 2006

Donald Hall (Wilmot, New Hampshire). *White Apples and the Taste of Stone: Selected Poems, 1946 – 2006*. Houghton Mifflin, April 2006

Geoffrey Hill (Boston University). *Without Title*. Yale University Press, November 2006; *Selected Poems*. Yale University Press, November 2006

Paul Muldoon (Princeton University). *Horse Latitudes: Poems*. Farrar, Straus & Giroux, October 2006

C. K. Williams (Princeton University). *Collected Poems*. Farrar, Straus & Giroux, November 2006

Fiction

Margaret Atwood (Toronto, Canada). *Moral Disorder: and*

Other Stories. Nan Talese, September 2006

Ward Just (Martha's Vineyard, Massachusetts). *Forgetfulness*. Houghton Mifflin, September 2006

Richard Powers (University of Illinois, Urbana-Champaign). *The Echo Maker*. Farrar, Straus & Giroux, October 2006

Anna Quindlin (New York City). *Rise and Shine*. Random House, August 2006

John Updike (Boston, Massachusetts). *Terrorist*. Knopf, June 2006

Nonfiction

Kwame Anthony Appiah (Princeton University). *Cosmopolitanism: Ethics in a World of Strangers*. W. W. Norton, January 2006

Michael Ashburner (University of Cambridge). *Won for All: How the Drosophila Genome was Sequenced*. Cold Spring Press, April 2006

Roger S. Bagnall (Columbia University) and Raffaella Cribiore (Columbia University). *Women's Letters from Ancient Egypt, 300 BC – AD 800*. University of Michigan Press, March 2006

Leonard Barkan (Princeton University). *Satyr Square: A Year, a Life in Rome*. Farrar, Straus & Giroux, October 2006

Robert N. Bellah (University of California, Berkeley) and Steven M. Tipton (Emory University). *The Robert Bellah Reader*. Duke University Press, October 2006

David P. Billington (Princeton University) and David P. Billington, Jr. (Santa Monica, California). *Power, Speed, and Form: Engineers and the Making of the Twentieth Century*. Princeton University Press, October 2006

Lawrence D. Bobo (Stanford University) and Mia Tuan (University of Oregon). *Prejudice in*

Politics: Group Position, Public Opinion, and the Wisconsin Treaty Rights Dispute. Harvard University Press, April 2006

T. J. Clark (University of California, Berkeley). *The Sight of Death: An Experiment in Art Writing.* Yale University Press, August 2006

Francis S. Collins (National Human Genome Research Institute). *The Language of God: A Scientist Presents Evidence of Belief.* Free Press, July 2006

James Cuno (Art Institute of Chicago). *Notable Acquisitions at the Art Institute of Chicago.* Yale University Press, June 2006

Robert A. Dahl (Yale University). *On Political Equality.* Yale University Press, August 2006

William Theodore de Bary (Columbia University), ed. *Living Legacies at Columbia.* Columbia University Press, June 2006

Daniel C. Dennett (Tufts University). *Breaking the Spell: Religion as a Natural Phenomenon.* Viking, February 2006

E. L. Doctorow (New York University). *Creationists: Selected Essays, 1993 – 2006.* Random House, September 2006

Mary Douglas (University College London). *Thinking in Circles: An Essay on Ring Composition.* Yale University Press, January 2007

Ronald Dworkin (New York University). *Is Democracy Possible Here? Principles for a New Political Debate.* Princeton University Press, September 2006

Gerald M. Edelman (Scripps Research Institute). *Second Nature: Brain Science and Human Knowledge.* Yale University Press, October 2006

Richard A. Epstein (University of Chicago). *Overdose: How Excessive Government Regulation Stifles Pharmaceutical Innovation.* Yale University Press, October 2006

Owen Gingerich (Harvard University). *God's Universe.* Harvard University Press, September 2006

Kent Greenawalt (Columbia University). *Religion and the Constitution: Volume I: Free Exercise and Fairness.* Princeton University Press, August 2006

James Oliver Horton (George Washington University) and **Lois E. Horton** (George Mason University), eds. *Slavery and Public History: The Tough Stuff of American Memory.* New Press, May 2006

Michael Kammen (Cornell University). *Visual Shock: A History of Art Controversies in American Culture.* Knopf, October 2006

Justin Kaplan (Cambridge, Massachusetts), *When the Astors Owned New York: Blue Bloods and Grand Hotels in a Gilded Age.* Viking, June 2006

George Kateb (Princeton University). *Patriotism and Other Mistakes.* Yale University Press, November 2006

Thomas H. Kean (Robert Wood Johnson Foundation) and **Lee H. Hamilton** (Woodrow Wilson International Center for Scholars). *Without Precedent: The Inside Story of the 9/11 Commission.* Knopf, August 2006

Nikki R. Keddie (University of California, Los Angeles). *Women in the Middle East: Past and Present.* Princeton University Press, December 2006

Donald Keene (Columbia University). *Frog in the Well: Portraits of Japan by Watanabe Kazan, 1793 – 1841.* Columbia University Press, July 2006

Roderick MacFarquhar (Harvard University) and **Michael Schoenhals** (Lund University). *Mao's Last Revolution.* Harvard University Press, August 2006

Edmund S. Morgan (Yale University), ed. *Not Your Usual Founding Father: Selected Readings from*

Benjamin Franklin. Yale University Press, November 2006

Linda Nochlin (New York University). *Bathers, Bodies, Beauty: The Visceral Eye.* Harvard University Press, May 2006

Sherry B. Ortner (University of California, Los Angeles). *Anthropology and Social Theory: Culture, Power, and the Acting Subject.* Duke University Press, November 2006

Richard A. Posner (U.S. Court of Appeals, Chicago). *Uncertain Shield: The U.S. Intelligence System in the Throes of Reform.* Rowman & Littlefield, April 2006; *Not a Suicide Pact: The Constitution in a Time of National Emergency.* Oxford University Press, August 2006

Kenneth Prewitt (Columbia University), **D. Sunshine Hillygus** (Harvard University), **Norman H. Nie** (Stanford Institute for the Quantitative Study of Society), and **Heili Pals** (Stanford University). *The Hard Count: The Political and Social Challenges of Census Mobilization.* Russell Sage Foundation, May 2006

Francine Prose (New York City). *Reading Like a Writer: A Guide for People Who Love Books and for Those Who Want to Write Them.* HarperCollins, August 2006

Theda Skocpol (Harvard University), **Ariane Liazos** (Harvard University), and **Marshall Ganz** (Harvard University). *What a Mighty Power We Can Be: African American Fraternal Groups and the Struggle for Racial Equality.* Princeton University Press, September 2006

Fritz Stern (Columbia University). *Five Germanys I Have Known.* Farrar, Straus & Giroux, August 2006

Immanuel Wallerstein (Yale University). *European Universalism: The Rhetoric of Power.* The New Press, June 2006

David Wiggins (University of Oxford). *Ethics: Twelve Lectures*

on the Philosophy of Morality. Harvard University Press, May 2006

E. O. Wilson (Harvard University). *The Creation: A Meeting of Science and Religion.* W. W. Norton, September 2006

William Julius Wilson (Harvard University) and **Richard P. Taub** (University of Chicago). *There Goes the Neighborhood: Racial, Ethnic, and Class Tensions in Four Chicago Neighborhoods and Their Meaning for America.* Knopf, October 2006

Exhibitions

Chuck Close (New York City): “Chuck Close Prints: Process and Collaboration” at the Orange County Museum of Art, Newport Beach, California, January 21 – April 22, 2007.

Bruce Nauman (Galisteo, New Mexico): “Mental Exercises” at NRW-Forum Kultur und Wirtschaft, Düsseldorf, Germany, September 9, 2006 – January 14, 2007.

Frederick Wiseman (Zipporah Films): upcoming film retrospective at La Cinémathèque Française and the Centre Georges Pompidou, Paris, France, October 28 – December 31, 2006.

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. ■

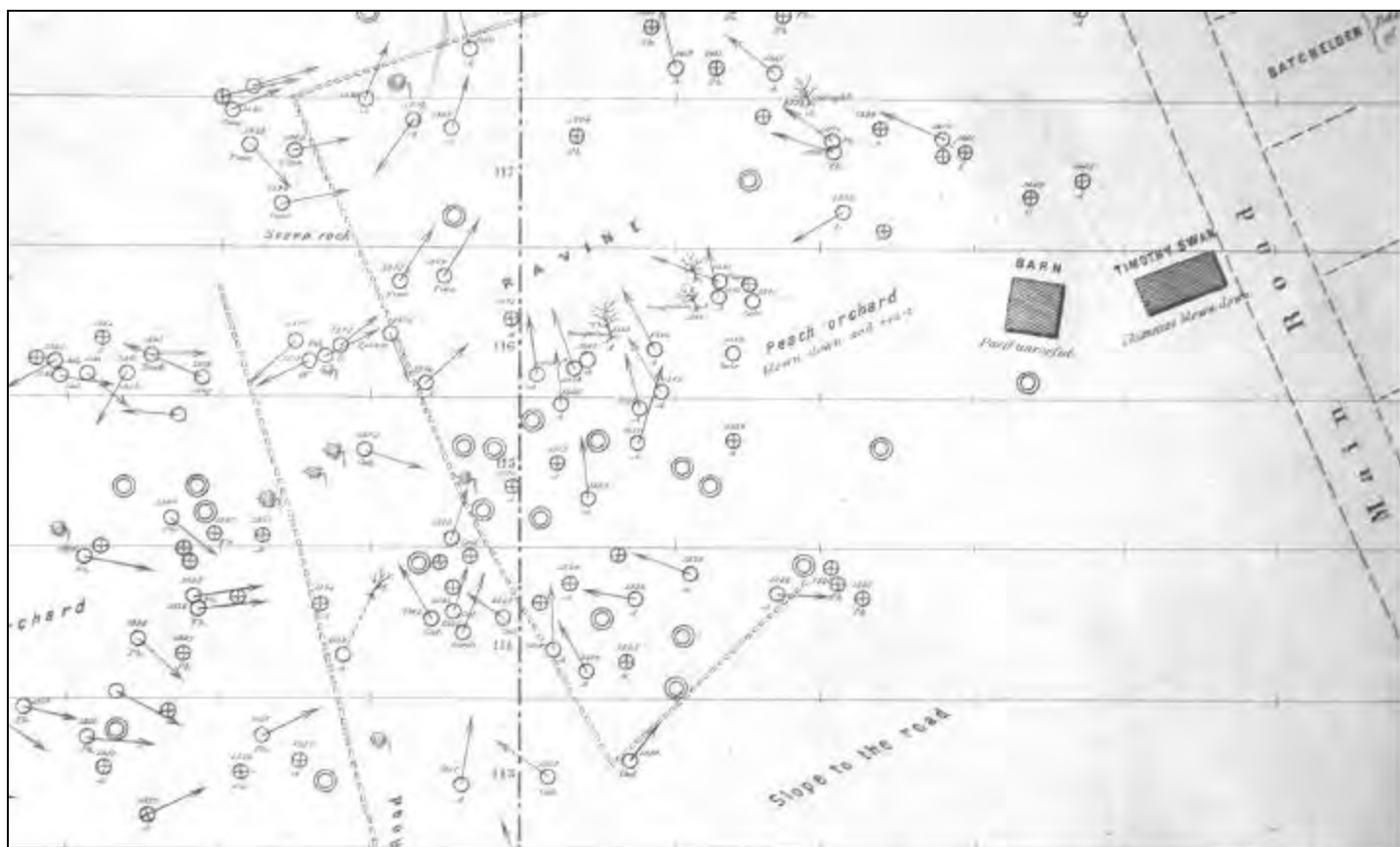
From the Archives

The early members of the Academy made meteorology one of their special concerns, along with agriculture and “the various soils of the Country...” Henry L. Eustis, a professor of engineering at Harvard University and a Fellow of the Academy (elected in 1850), drew a “Plan exhibiting the Ravages of the Tornado of August 22d 1851, Embracing so much of its course as is included between the base of Wellington Hill in Waltham and Mystic River” to illustrate his article on the tornado (an excerpt is reprinted below). The pupils of the Engineering Department of the Lawrence Scientific School assisted Eustis in creating the map. Unfolding to over 14 feet, the map is mounted on linen and shows the path of the tornado in great detail (tree by tree); a portion of the map also appears below.

Meteorology is every day gaining a stronger foothold, and taking a higher rank among the sciences of modern times. It would be no great tax upon our powers of retrospection, to look back to the period when its deductions were regarded, by most persons, as the mere speculations of scientific enthusiasts, having no tests whereby their fallacy or accuracy could be demonstrated, and therefore possessing little practical value. . . .

To those who have lived where the hurricane or the tornado is an event of common occurrence, it would be impossible to convey any idea of the intense excitement caused in this community by the tornado of August 22, 1851. It swept through the towns of Waltham, West Cambridge, and Medford, prostrating in its path orchards, fences, forest-trees, and buildings, and involving in a few instances the loss of human life. While multitudes visited the scene of its ravages from mere motives of curiosity, and stood appalled before the exhibition of such wondrous power, scientific men sought to explore its mode of action, and to find there a corroboration or a refutation of their preconceived views. It was in obedience to the call of many of this latter class, that I undertook the survey whose results are embodied in the accompanying map.

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AMERICAN ACADEMY
OF ARTS & SCIENCES

Norton's Woods, 136 Irving Street, Cambridge, MA 02138
telephone 617-576-5000, facsimile 617-576-5050,
email aaas@amacad.org, website www.amacad.org

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Martha Stewart	pages 1, 27, 35, 52-53
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Gail Oskin	page 16
Mike Fox	pages 42-43

ERRATUM

In an essay by Veerabhadran Ramanathan on "Global Warming," published in the Spring 2006 issue of the *Bulletin*, it incorrectly stated that the world population increased by over 60 percent in the 1950s. It should have read "the world population increased by over 60 percent since the 1950s."