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AMERICAN ACADEMY
OF ARTS & SCIENCES

Annual Fund Seeks to Top $1 Million Again

The Academy's 2002–2003 Annual Fund Campaign was launched in October. Many Fellows have already made contributions to the Fund for the New Century. We are grateful for your support as we seek to surpass the $1 million level again this year.

Every gift counts toward reaching our ambitious goals. The Academy's fiscal year closes on March 31, 2002. Please be as generous as you can.

For assistance in making a gift to the Academy, please contact the Development Office (e-mail: dev@amacad.org; phone: 617–576–5057).

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CALENDAR OF EVENTS

All members of the Academy are cordially invited to participate in any listed event, as space allows. Special notices are sent to Fellows who reside in areas where specific meetings are held. A list of forthcoming Stated Meetings appears on the back cover.

Wednesday, February 12, 2002

1867th Stated Meeting—Cambridge

Communication: "Art, Race, and the Coldest War: The Image of the African American Soldier in Three Hollywood Korean War Films"

Speaker: **Gerald Early,** Washington University in St. Louis

At the February Stated Meeting in Cambridge, author and essayist Gerald Early will speak on "Art, Race and the Coldest War: The Image of the African American Soldier in Three Hollywood Korean War Films." He brings to his subject a long-standing interest in African American and popular culture, ranging from boxing to jazz.

Early is the Merle Kling Professor of Modern Letters, a professor of English and of African and Afro-American studies, and the director of the International Writers Center at Washington University in St. Louis. He is the editor of several volumes, including the *Sammy Davis, Jr., Reader* (2001) and *The Muhammad Ali Reader* (1998). He is also the author of the *Culture of Bruising: Essays on Prizefighting, Literature, and Modern American Culture,* which won the 1994 National Book Critics Circle Award for criticism. He was a consultant for the Ken Burns baseball and jazz documentaries aired on public television. A Fellow of the Academy since 1997, Early currently serves as a Councilor and as a member of the Committee on the Initiative for Humanities and Culture.

For reservations, contact Sheri Bugbee (phone: 617–576–5034; e-mail: sbugbee@amacad.org).

Wednesday, March 12, 2003

1868th Stated Meeting—Cambridge

Program: "A Tribute to Herman Feshbach and Victor Weisskopf"

Speaker: **Steven Weinberg,** University of Texas, Austin

The March Stated Meeting in Cambridge will be a tribute to two past presidents of the Academy: Herman Feshbach (1982–86) and Victor Weisskopf (1976–79).

Throughout their careers, both Herman and Viki worked to control the spread of nuclear arms, to foster East-West cooperation, and to champion scientific freedom around the world. They brought their deep concern with these issues to the Academy's studies on international security and to its efforts to advance productive nongovernmental exchange with the Soviet Union and Eastern Europe.

The speaker on this special occasion will be Steven Weinberg, Professor of Physics and Astronomy at the University of Texas, Austin. Weinberg is founder and director of the Theory Research Group at Texas, where he holds the Josey Regental Chair of Science.

Weinberg's research has spanned a broad range of topics in quantum field theory, elementary particle physics, and cosmology. He has been honored with numerous awards, including the 1979 Nobel Prize in Physics, the National Medal of Science, and the Cresson Medal of the Franklin Institute.

In addition to his well-know treatise *Gravitation and Cosmology,* he has written several books for the general reader, including *The First Three Minutes* (translated into twenty-two languages) and, most recently, *Facing Up: Science and Its Cultural Adversaries,* in which he considers the culture, philosophy, history, and politics of science. He is also a contributor to the *New York Review of Books.* Weinberg has been a Fellow of the Academy since 1968.

For reservations, contact Sheri Bugbee (phone: 617–576–5034; e-mail: sbugbee@amacad.org).

Visiting Scholars Program Under Way

The Visiting Scholars Program (VSP) was launched in September 2002 with the arrival of seven post-doctoral fellows and junior faculty members from universities across the country. The objective of the VSP is to stimulate and support research on multi-disciplinary topics closely related to the Academy's program of studies. The work of this year's class covers a broad range of topics: the use of school vouchers in developing countries; international peacekeeping; nominations to the Supreme Court; the life and work of F. O. Mathiessen, the noted scholar of American literature; American modernism; the writings of twentieth-century poets as a reflection of social, political, and economic inequalities; and the relation of scientific knowledge to democratic governance.

In the short time they have been at the Academy, the visiting scholars have become a closely knit group, as well as an integral part of the Academy's project and social activities. Throughout the year, they will be

James Carroll (*Boston Globe*), chair of the Visiting Scholars Program, with Supreme Court Justice David Souter at the first VSP meeting.

Special Gift to the Visiting Scholars Program

A new gift from **Charles and Suzanne Haar** has added another dimension to the Visiting Scholars Program. In cooperation with the Jerusalem Foundation, they have established the Esther Haar Scholarly Exchange Program, which will provide reciprocal study opportunities for American and Israeli artists and scholars as part of the VSP. The exchange program will enrich the Academy's continuing efforts to bring together junior and senior scholars who share an interest in the social and intellectual issues that are at the center of the Academy's work.

presenting their work at a series of research seminars attended by their colleagues, Academy program directors, and interested Fellows. To complement their individual research, Visiting Scholars also participate in conferences and workshops organized by the leaders of Academy projects. They attend Stated Meetings and informal gatherings at the House, as well as the monthly Friday Forums, which bring together academic, business, and cultural leaders in the Boston area for conversation on timely issues. These varied activities are creating a network of opportunities that will assist the scholars in their research and professional development.

In spring 2003, Academy Fellow **David Hollinger** (UC Berkeley) will participate in the VSP for several weeks as a senior scholar. Hollinger is developing a study of the social forces that have transformed the humanities since World War II, as part of the Academy's Initiative on Humanities and Culture.

Author, historian, and Academy Fellow **James Carroll** chairs the VSP. As Carroll observes, "The Academy's commitment to the future is embodied in the work of the Visiting Scholars Program," which "mirrors the Academy's long-standing concern with scholarly and intellectual issues that can be studied most effectively through a multidisciplinary approach." In his words, "the scholars have brought something very special to the Academy, enriching its work and its activities with lively con-

versation and new perspectives." During his tenure at the VSP, Carroll will be working on a study of the Pentagon.

The Academy gratefully acknowledges the many Fellows from varied fields and professions who served on the preliminary review panels and overall advisory committee that selected the 2002–03 class of scholars. It is also indebted to the 41 University Affiliates, the Annenberg Foundation, and the Virginia Wellington Cabot Foundation for their generous support of the VSP.

An article on the Visiting Scholars Program, together with a more detailed description of each scholar's research, is featured in "Induction," the Fall 2002 edition of the Academy's Newsletter.

Project Updates

The Rule of Law in Space

"Reconsidering the Rules of Space," a project of the Academy's Committee on International Security Studies (CISS), is examining a central problem of outer-space development: the establishment of a viable balance among military, commercial, and scientific activities under rapidly changing conditions. Academy Fellow and CISS chair **John Steinbruner** (University of Maryland) is leading the project, with support from the Carnegie Corporation of New York and the W. Alton Jones Foundation.

In recent meetings convened by CISS at the Academy, Fellows and other experts noted that current plans to deploy a missile defense system, accompanied by proposals for weapons deployment in space, are at once eroding existing rules and norms governing the peaceful use of space and provoking countervailing responses in China and elsewhere. Repeated Chinese overtures to discuss arms control measures in space have been ignored by the United States. Because objects in space are potentially vulnerable to interference, the situation, if unresolved, could eventually put at risk valuable, satellite-dependent scientific exploration, military support activities, and commercial services.

Scholars from various backgrounds and perspectives are investigating several aspects of these issues, including technological advances in the development of space, the constituencies involved in determining the use of space, and the legal means of protecting a broad range of peaceful activity in space. In the coming months, the Academy will issue an Occasional Paper examining Chinese perspectives on, and likely responses to, US space plans. Three additional working groups are now being formed: one to examine technical developments and constraints on defending satellites, a second to study the history of efforts to protect satellites from interference, and a third to review commercial space industry perspectives on missile defense and arms control. The findings of all three groups will be published as Academy Occasional Papers.

In October, Steinbruner joined **George Abbey** (former director, Johnson Space Center) and Academy Fellow **Neal Lane** (Rice University) for a meeting with commercial satellite industry executives to discuss the interaction of commercial and military activities in space, with particular attention to the effects of national security concerns on the future of the commercial satellite industry. Abbey and Lane hosted the meeting at Rice University's Baker Institute for Public Policy.

Universal Basic and Secondary Education

The Academy's project on Universal Basic and Secondary Education (UBASE), codirected by **Joel E. Cohen** (Rockefeller and Columbia Universities) and **David E. Bloom** (Harvard School of Public Health), held a meeting of its working group on educational assessment on October 2, 2002. Participants reviewed a draft paper by **Henry Braun** (Educational Testing Service) and **Anil Kanjee** (Human Sciences Research Council, South Africa) that considered models and strategies of assessment, the wide range of political and economic conditions under which educational achievement and quality are measured, and how assessment methods can be improved as tools for educators and

Anil Kanjee (Human Sciences Research Council, South Africa) and Denise Lievesley (UNESCO Institute of Statistics).

national policymakers. The report will be published in the Academy's Occasional Paper series.

In October, Cohen and Bloom also spoke about the UBASE project at Academy gatherings. Bloom led a discussion of the project with new Fellows during the orientation session at the Academy induction. At a meeting of New York area Fellows, Cohen described a number of "intellectual surprises" he encountered while working on the study, including the paucity of reliable basic data on education, despite the increasing prominence of the issue in international political forums, and the complex, nonlinear relationship between education and fertility.

In August, Cohen and Bloom published "Education for All: An Unfinished Revolution" in *Daedalus* (Summer 2002). It reviewed progress toward the realization of universal education, identified remaining obstacles and imperatives, and underlined the importance of an approach to global education that places research before advocacy.

In addition, in January 2003, the Academy will publish an Occasional Paper by **Emily Hannum** (University of Pennsylvania) and **Claudia Buchmann** (Duke University), reviewing social science perspectives on educational expansion.

The UBASE project is supported by a major grant from the William and Flora Hewlett Foundation and by funds from John Reed, the Golden Family

Foundation, Paul Zuckerman, and the Sergei Zlinkoff Fund for Medical Research and Education.

Corporate Responsibility

The Academy is in the exploratory phase of a project to examine the factors that led to the recent wave of corporate misconduct and to propose concrete steps toward more responsible corporate behavior and the restoration of the trust that is essential to a healthy economy. The distinguished group of scholars and practitioners taking the lead in designing the new study include Martin Lipton (Wachtell, Lipton, Rosen & Katz, New York), Lawrence Sonsini (Wilson, Sonsini, Goodrich & Rosati, Palo Alto), Jay Lorsch (Harvard Business School), Douglass North (Washington University in St. Louis), William Allen (New York University), Margaret Blair (Georgetown University Law Center), Michael Useem (Wharton School), John Biggs (TIAA-CREF), Amory Houghton, Jr. (US House of Representatives), Michael Gellert (Windcrest Partners), John Reed (New York City), Felix Rohatyn (New York City), E. John Rosenwald (Bear Stearns Companies), Richard Buxbaum (Boalt Hall School of Law, UC Berkeley), and William McDonough (Federal Reserve Bank of New York). The project's planning committee held its initial meeting in New York in September 2002, and a working group has been charged with refining the project proposal to develop both a long-term study and a shorter-term, policy-oriented series of recommendations.

Academy Meetings Around the Country

This fall, hundreds of Fellows and guests took part in the Academy's expanding outreach program, with formal and informal meetings across the country. Following an Induction Ceremony in Cambridge with over 500 people in attendance, nearly 200 Academy members and guests greeted inductees at meetings in New York City; Minneapolis, Minnesota; and Napa Valley, California. President **Patricia Meyer Spacks** (University of Virginia) and Vice President **Louis Cabot** (Cabot-Wellington,

LLC) joined Executive Officer **Leslie Berlowitz** to introduce new members to the Academy's work.

New York City

Rockefeller Foundation president **Gordon Conway** joined Academy officers to welcome newly elected Fellows at a gathering in New York on October 21, 2002. **Joel E. Cohen** (Rockefeller and Columbia Universities), cochair of the Committee on Universal Basic and Secondary Education (UBASE), outlined the Academy's efforts to explore the means and consequences of educating all the world's children (see p. 8).

Minneapolis, Minnesota

On October 26, 2002, the Midwest Center, chaired by Martin Dworkin (University of Minnesota), held a Stated Meeting at the Minneapolis Institute of Arts. In a talk entitled "*The Comedy of Errors* as Early Experimental Shakespeare," **David Bevington** (University of Chicago), an authority on Renaissance drama, argued that *The Comedy of Errors* may be Shakespeare's first comedy, displaying a neoclassical style not found in later works. The event included a performance of the play at the Guthrie Theater, as well as a private tour of the exhibit "America Sublime: Epic Landscapes of Our Nation, 1820–1880" at the Minneapolis Institute.

Napa Valley, California

Western Center Cochair John Hogness (University of Washington) presided at the fall Stated Meeting held in Napa Valley, California, on November 2. A talk by **Carole P. Meredith** (UC Davis) on "Science as a Window into Wine History" was complemented by tours of the Robert Mondavi Winery and COPIA: The American Center for Wine, Food, and the Arts. A specialist in the genealogy of grapes, Meredith described how DNA profiling techniques used in human paternity analysis have been applied to grapevines to reveal the parentage of such wines as Cabernet Sauvignon, Chardonnay, and Zinfandel.

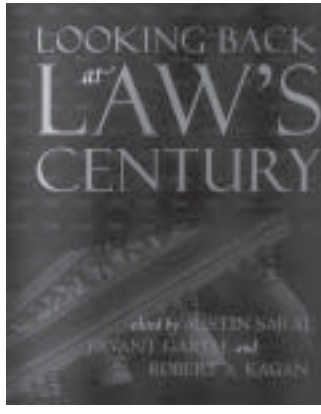
At Stated Meetings at the House of the Academy in Cambridge, the cochair of the Committee on

International Security Studies, **John Holdren** (Harvard University), discussed "Global Environmental Change and the Human Condition," and statistician **Persi Diaconis** (Stanford University) considered the obstacles to understanding random phenomena in a talk entitled "The Problem of Thinking Too Much."

On December 4, 2002, art historian and curator **J. Kirk Varnedoe** (Institute for Advanced Study) spoke on "Matisse, Picasso, and the Idea of Influence" at Rockefeller University in New York City. A meeting on judicial independence is planned for Washington, DC, in the spring.

The text of these presentations and information about forthcoming meetings will be posted on the Academy website at www.amacad.org *and printed in future issues of the* Bulletin.

Academy Fellows Contribute to Law Retrospective



Looking Back at Law's Century, published by Cornell University Press, describes the complex interaction of democracy, capitalism, and legal change in the twentieth century. "The last hundred years—what we might in retrospect characterize as 'law's century'—took us from the Progressive Era's optimism about law and social engineering to current concerns about our hyperlegalistic society, from Wilsonian idealism to the worldwide spread of democracy, the rule of law, and the idea of human rights," observe the volume's editors, **Austin Sarat** (Amherst College), **Bryant Garth** (American Bar Association),

and Academy Fellow **Robert A. Kagan** (UC Berkeley). Other Academy Fellows who contributed to the book include **Owen Fiss** (Yale University), **Morton Keller** (Brandeis University), and **Martha Minow** (Harvard Law School).

The Academy cosponsored the conference that led to the publication of *Looking Back at Law's Century*. Among the topics covered in the book are race and citizenship, individual and group identity, crime and punishment, the legal profession, democracy and freedom, the liberal state, corporate governance, civil society, and the teaching of law.

For more on Looking Back at Law's Century*, including information on ordering the book online or via fax, visit* www.cornellpress.cornell.edu. *To order by phone, call 800–666–2211.*

John Edsall Bequest

The Academy gratefully acknowledges a legacy gift from **John Edsall**, who passed away on June 12, 2002. A professor of biochemistry at Harvard University, Edsall was elected to the Academy in 1937 in recognition of his distinguished research on the chemistry and structure of proteins. He was a member for 65 years—longer than any Fellow in recent memory. During his career, he brought to the Academy and to other organizations his deep interest in the larger context of his work: the historical development of biochemistry and the importance of scientific responsibility. In the 1970s and 1980s he led a series of Academy studies on the history of biochemistry, bringing leaders in the field together with young historians of science to examine the influences that shaped the discipline. In his life and his writings, he demonstrated an abiding concern with the ethics of science. When his report on scientific freedom and responsibility appeared in the mid-1970s, it stood alone as a major statement on the ethics of research practices in this country.

John Edsall evidenced the wisdom, dedication, and moral leadership of the scientific community. The Academy honors his accomplishments and accepts his bequest with gratitude.

2002 INDUCTION CEREMONY

On October 5, 2002, the Academy welcomed its 223rd class of members at an Induction Ceremony at Harvard's Sanders Theatre. Nearly 75 percent of this year's class of 177 Fellows and 30 Foreign Honorary Members attended. An overview of the ceremony was published in the Fall 2002 edition of the Academy's *Newsletter*.

President **Patricia Meyer Spacks** (University of Virginia), Vice President **Louis Cabot** (Cabot-Wellington, LLC), Secretary **Emilio Bizzi** (MIT), and Executive Officer **Leslie Berlowitz** congratulated each of the new members in turn. Six inductees addressed the membership on the challenges facing the world and the Academy at the beginning of a new century: cosmologist **Edward W. Kolb** of the Fermi National Accelerator Laboratory and the University of Chicago, medical researcher **Nancy Andreasen** of the University of Iowa, historian and dean **Philip S. Khoury** of MIT, novelist **Chinua Achebe** of Bard College, news analyst **Daniel Schorr** of National Public Radio, and US Senator **Edward M. Kennedy** of the Commonwealth of Massachusetts. Their remarks appear below, in the order presented.

Edward W. Kolb

In this hyperspecialized and finely partitioned modern world, there is precious little contact between the sciences, the humanities, the arts, and government. One of the hallmarks of this Academy is that it brings together artists, writers, scientists, and politicians so we can stand together, arms locked in camaraderie, and present a united front for the arts and sciences.

I would like to make some remarks about connections between seemingly unrelated investigations. The great American naturalist and conservationist John Muir said, "When you tug on a single thing in nature, you find it connected to the rest of the universe." Organizations may divide the sciences into departments, from astronomy to zoology, but Nature herself is not so neatly partitioned. As Muir said, everything is connected to the rest of the universe.

Edward W. Kolb (Fermi National Accelerator Laboratory and University of Chicago).

The most exciting research areas in the sciences are interdisciplinary. It's a magic moment when people realize that single things they are tugging on are a common thread in nature's tapestry. We seem to be in the midst of such a realization in the study of the universe.

As a cosmologist, I study the largest objects in the universe—galaxies and filamentary structures hundreds of millions of light years across. But I work at Fermilab, a particle accelerator laboratory, where we probe the smallest things in the universe—quarks and other fundamental particles and forces. The remarkable fact is that to understand the largest things, we must study the smallest things. We believe that galaxies and everything else in the cosmos arose from the action of submicroscopic forces in the first billionth of a second after the big bang. We can't understand galaxies without understanding quarks. Tugging on quasars connects us to quarks.

Modern cosmology began a hundred years ago in Bern, Switzerland, when a Swiss civil servant—a technical expert third class, working in the patent office—scribbled some equations on a piece of paper and started down the road to relativity. The discoveries of Albert Einstein sparked the scientific revolution of the twentieth century. They rank among humanity's greatest achievements. They are

part of the framework for our understanding of the origin and evolution of the universe.

The development of the big bang model by Einstein and others was a triumph of twentieth-century science. We now understand the evolution of the universe from the time of the bang, 15 billion years ago, until today. In spite of the great successes of modern cosmology, I believe that as we start the twenty-first century, we are poised for a sweeping revolution in our understanding of the universe.

The reason I think we are on the verge of a new revolution traces back to, of all things, an accounting irregularity—one that makes recent accounting issues look like small change. I don't want to alarm you, but 95 percent of the mass and energy of the entire universe seems to be missing. Well, it's not exactly missing—we know it is there, because we can measure its effects—but it seems to be invisible.

This is a story that has been unfolding since 1933, when astronomers first suspected that there was much more to the universe than meets the eye. Striking recent observations confirm that the neutrons, protons, and electrons of which we are made comprise just a few percent of the total mass of the universe. It seems that most of the universe is in the form of an undiscovered elementary particle.

In 1543 the Polish astronomer Nicholas Copernicus proposed that Earth is not the center of the solar system. In 1918 the American astronomer Harlow Shapley, a former president of the American Academy of Arts and Sciences, proved that our solar system is not the center of our galaxy, and in 1924 the American astronomer Edwin Hubble discovered that our Milky Way galaxy is but one of billions in the universe. Perhaps we have finally reached the end of the Copernican revolution. Not only are we not at the center of the universe, but also, the very stuff of which we are made is only a very small fraction of the matter of the universe.

Just when we started to face up to the possibility of invisible matter, in 1998, astronomers uncovered evidence that the universe is being pulled apart by

a mysterious dark pressure force. It seems that every nook and cranny of space is full of a new type of dark energy. If this is true, each liter of space contains a million volts of dark energy.

Thankfully, cosmic accounting irregularities are not a scandal but an opportunity. Unlocking the secrets of dark matter and dark energy may spark a new revolution as far-reaching as Einstein's. Perhaps there are more than three dimensions of space. Infinite, hidden dimensions may be awaiting discovery. Or maybe the fundamental building blocks of nature are not particles after all, but extended objects we call strings. Perhaps there is more to gravity than Newton or even Einstein imagined. Whatever the explanation, it is certain to involve the interplay of nature on the smallest scales and on the largest scales.

As a theoretical physicist, I am paid to make predictions, so I'll predict that in five years the dark matter and dark energy will be understood to result from the existence of dimensions of space we have yet to explore. I could also predict exactly how this remarkable discovery will revolutionize philosophy, art, religion, government, technology, and everyday life, but I see that my five minutes are up.

President Patricia Meyer Spacks (University of Virginia), Vice President Louis Cabot (Cabot-Wellington LLC), and Secretary Emilio Bizzi (MIT).

As a representative of the biological sciences, I'd like to speak briefly about the importance of integrity—particularly integrity in the twenty-first century. A comment made by Albert Einstein in a lecture at the California Institute of Technology will provide a context for my remarks: "Concern for man himself and his fate must always be the chief interest of all technical endeavors . . . in order that the creations of our mind shall be a blessing and not a curse to mankind." Einstein, above all, understood the promises and the perils of science.

Why integrity? Because the essence of its meaning—derived from *integer,* or oneness—provides us with a compass that we may use to navigate between the perils and promises that we will confront in the biological sciences during the twenty-first century. It may serve to remind us that we must seek, achieve, and teach integration rather than divisiveness, and that our decisions today must be shaped by a recognition that we all share a oneness with humanity, here on the one planet on which we live, now and for what we all hope will be many future generations.

Einstein's century was the century of physics. Basic and applied physics have given us many things: airplanes and spaceships, telephones and television, computers and compact discs, nuclear power and nuclear weapons. In the year 2002 we can communicate with one another, and also harm one another, in ways that we would never have dreamed of in the year 1902.

Our century is likely to become the age of biology. At the fine-grained level of cells and molecules, we have launched the twenty-first century by mapping the genome. This accomplishment, much touted in the media, is exceedingly modest in comparison with what is yet to be done. We are already beginning to perceive just a few of the sensational (and sensationalized) implications, such as the ability to clone sheep or human beings. The science of molecular biology offers us many benefits. We can potentially replace damaged genes or damaged cells

Nancy Andreasen (University of Iowa).

in order to treat, and perhaps even cure, a variety of diseases: cystic fibrosis and multiple polyposis, Parkinson's disease and Alzheimer's disease, cardiac disease and cancer. We will also be able to summarize the biological contents of every individual human being by the ultimate identity card: a profile of the individual genetic mutations that uniquely characterize each of us, or single nucleotide polymorphisms (SNPS), colloquially referred to as "snips." This summary of personal genetic endowment is a quintessential definition of what each person actually is, or is going to become, at the biological level. Will we know how to use this and other genetic information wisely, once we have it?

At a higher level, we are also mapping the human brain, using the tools that I happen to pursue. Technologies such as magnetic resonance imaging and positron emission tomography permit us to look inside the human head and literally watch the brain think and feel. Within a few minutes after obtaining a magnetic resonance scan, we can give someone a picture of her brain and tell her its size in cubic centimeters, how much of it is gray matter, and how much is white matter. Only a few years ago, such vivid pictures of the whole brain surface could be obtained only after death. Now we can obtain these measures in living human beings, repeat them every year if we wish, and plot

how the brain is growing in young children or shrinking in older people as they age. We can see the brain shift its blood flow to multiple interconnected regions when people perform the many complex mental tasks that make us human—remembering the past, planning the future, feeling joy or sorrow. Through magnetoencephalography we can even watch this happen in real time, observing how the visual cortex records an image of a face and then passes it on to areas such as the frontal or temporal lobes so that the brain can recognize whose face it is. We can also see how the brains of people with illnesses such as schizophrenia, Alzheimer's disease, or autism perform these mental activities differently. Someday these imaging tools may permit us to predict who is likely to become ill even before the illness itself begins. Such measures of personal brain endowment may also someday tell us not only what each person is, but also what that person is going to become, at the biological level. Again, will we know how to use this information wisely, once we have it? Will we use it to prevent diseases and develop new treatments, or will we use it to find more sophisticated ways to discriminate against and stigmatize the unfortunate people who have or will develop brain illnesses, such as schizophrenia?

We biological scientists are being inducted into the American Academy of Arts *and* Sciences, not arts *or* sciences. C. P. Snow warned many years ago about the dangers of creating "two cultures," the culture of the humanities and the culture of science. My own personal journey has taken me from being a young professor of Renaissance English literature to now being a somewhat older physician and neuroscientist. Although people sometimes comment on how disparate these two careers are, I find that I am sustained by my training in the humanities on an almost daily basis as I perform my activities as a scientist. In order to use wisely the enormous biological knowledge that we will develop in the twenty-first century, we must create a healthy integration between domains such as philosophy or history and domains such as molecular genetics or neuroscience. Ultimately, we will find

the integrity that we need to exploit the promises and avoid the perils of modern biology by creating a unified discourse between the two cultures embodied in this Academy—the cultures of the arts and the sciences.

This sense of our twenty-first-century need for oneness, integrity, and integration—whether it be a unity of past, present, and future, of I and thou, or of arts and sciences—is beautifully expressed by William Butler Yeats in the final lines of one of my favorite poems, "Among School Children":

> O chestnut tree, great-rooted blossomer,
> Are you the leaf, the blossom, or the bole?
> O body swayed to music, O brightening glance,
> How can we know the dancer from the dance?

Philip S. Khoury

I have been asked to speak on behalf of the humanities and social sciences. As a historian, I am part of both, though I must admit that I am also somewhat out of fashion in each. For instance, I belong neither to the wing of the humanities associated with cultural studies nor to the wing of the social sciences that applies mathematical and other methods of measurement to the study of socioeconomic and political behavior. But as an academic administrator responsible for the humanities and social sciences at my university, I have greatly benefited from the opportunity to read and debate with colleagues belonging to these two very different approaches to learning—approaches that in some sense constitute the methodological bookends of the humanities and social sciences.

I think that one of the most difficult challenges facing the humanities and social sciences in this trying period in our country's history is how to raise the level of awareness of cultures other than our own, and especially of so-called non-Western cultures, which I shall refer to as "distant cultures." As an area studies specialist, I have thought about

Newly elected Fellow Philip S. Khoury (MIT).

this challenge for many years, but never with more urgency than in the past year.

For all that the forces of globalization have done to make our world visibly interdependent, and for all the information and knowledge-sharing that the technologies underpinning globalization have produced, it is quite remarkable how parochial we Americans still seem to be in our understanding of distant societies and, by extension, in our interactions with some of them. There are reasons for this parochialism: the vast size of the United States and its historic self-containment; our comparatively recent involvement with much of the rest of the world outside of Europe; and our tendency to judge other societies in terms of how they resonate with our two most cherished values of individual freedom and democracy (even though we have tended to suspend their promotion abroad when they conflict with our strategic and material interests).

In the wake of the monstrous tragedy of September 11, Americans—in spite of shock, anger, and puzzlement—have begun to express an unprecedented (in my experience) desire for information and analysis about the complex and diverse cultures and societies of the Middle East and the wider Islamic world, and even beyond. Unfortunately, what the public has mainly had to rely on are simplistic theories and frameworks of interpretation

that view the world in terms of opposites, of backwardness against progress, of clashing civilizations, of the forces of evil against the forces of good. Meanwhile, those who have other knowledge and who have long rejected simplistic theories and frameworks for more richly nuanced portraits of distant cultures are seemingly incapable of rendering them intelligible to the public. Why? In part because our specialized, rather insular training has hindered the development of sufficient numbers of synthesizers and generalizers among us, and in part because those who have such capacities have not managed to gain regular access to our country's major channels of communication.

The challenge, then, is to bring greater understanding of distant cultures and societies to an American public whose curiosity is growing. Our interpretations must be critical and unapologetic, but they must not presume that cultures other than our own are inferior or are bent on undermining our values and traditions, September 11 notwithstanding. In this way, we will contribute to making ourselves more responsible citizens and to raising the quality of debate within our government and policymaking circles. And in this way we will be able to send to the sidelines both the cultural chauvinists and the romantic apologists who are lowering the quality of public discourse in this country.

I would note that at the very time that we, as Americans, are trying to increase our awareness of distant cultures, we are trying even harder to locate and reassert our own core values. We are doing so not only in reaction to the "attack against America" but also in reaction to an attack from within America by some whose enormous personal greed has shaken our confidence and trust.

Any one of us whose business it is to study societies other than our own knows that it is impossible to do so without revisiting our own values and traditions. I would suggest that in these unsettling times, there is an unusual opportunity to connect our desire and need to better understand distant cultures with our desire and need to examine and assert our own fundamental values.

Let me conclude by circling back to the humanities and social sciences. Many of us gathered here today know that the value of a liberal arts education has been diminished in the past quarter-century. The humanities and related social sciences are less influential in our educational system and in our wider society than they once were. There are complex factors behind this loss of status and importance. We humanists and social scientists bear some of the responsibility for not making our learning more accessible to the public and for not battling effectively the spread of narrowly oriented technical training within our institutions of higher education. My hope is that by accepting the responsibility to increase awareness of and engagement with more distant cultures and societies, and by linking this effort to a reexamination of our own history and increasingly rich and diverse culture, we can strengthen the position of the humanities and the social sciences, and of liberal education generally.

The American Academy of Arts and Sciences, of which I feel privileged to be a member, is already taking the lead in making the case for the humanities through its Initiative for the Humanities and Culture. Perhaps the Academy would also consider taking up the challenge of how to effectively transmit learning to the American public about distant cultures and, by extension, how to develop connections between this learning and the ongoing reexamination of our own social and cultural

Visiting Scholar Andrew Jewett with newly elected Fellow Anne-Marie Slaughter (Princeton University).

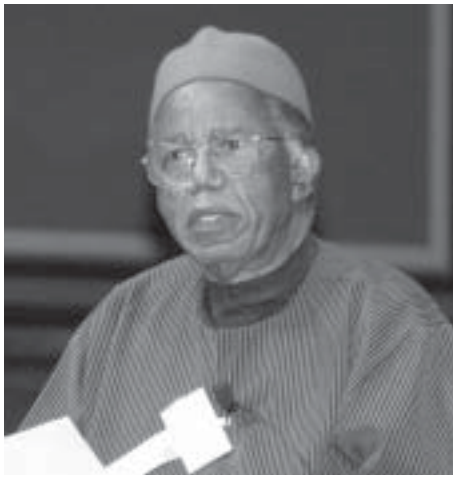
underpinnings and historical development. And while we are at it, shouldn't we consider how to more effectively transmit learning about American society, traditions, and values in a critical and unapologetic manner to those very same distant societies that we need to know much more about? They are no less in need of knowing us than we are of knowing them. By so doing, we might at long last produce a genuine dialogue of cultures.

Now, that's at least a double challenge!

Chinua Achebe

Three years ago, here in Cambridge, Ernest Hemingway's African writing was considered sufficiently important and interesting by the organizers of his centennial celebration to deserve a panel of its own, called "Writing Africa." I was on that panel, as were Nadine Gordimer, K. Anthony Appiah, and two Americans. One of the major themes of our discussion was Hemingway's apparent lack of real interest in his African characters. Professor Appiah contrasted, to good effect, the elaborate attention Hemingway pays to what goes on in the mind of a wounded and vengeful lion in the short story "The Short Happy Life of Francis Macomber" with the absence of any concern for what goes on in the minds of the African servants who serve the whiskey and carry the guns for the white hunters on safari. At question time, a young woman, clearly offended by our criticism of Hemingway, asked how *we* would write Africa. I replied, "Read our books." I doubt that she rushed away to follow this advice.

If I had to deal with that challenge again, I would be more patient. I would tell that young woman that what African writers do is take stories of Africa written by Westerners and stand them on their heads by giving center stage to those servants who bring the whiskey and carry the guns, as Nadine Gordimer does in *July's People* and as I do in everything I write. In dealing with the gigantic problem of using a European language as a medium for writing Africa, I have rejected the exotic broken



Chinua Achebe (Bard College).

English preferred in Europe's tradition of so-called African romances. The English language has as many dialects as anyone could wish, from that used in the King James version of the Bible to countless varieties of authorized and unauthorized speech. I have chosen a version of English capable of matching the eloquence and gravitas of the speech of African elders. If you read the kinds of books I read growing up, in which African savages are presented, you will remember that they have no speech; they howl, screech, make all kinds of other noises.

What I heard growing up in my village was different, and that's what I write about. I'm going to read you a short passage* from my first novel, *Things Fall Apart,* about an event in the life of the character Okonkwo. Okonkwo is in deep trouble. He is exiled from his community. He flees to his mother's village far away and is received by his uncle, Uchendu, but he is in great despair. The uncle, seeing that Okonkwo is heading for deeper trouble, calls a meeting of the kindred to give advice to Okonkwo:

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On the second day Uchendu called together his sons and daughters and his nephew, Okonkwo. The men brought their goatskin mats, with which they sat on the floor, and the women sat on a sisal mat spread on a raised bank of earth. Uchendu pulled gently at his gray beard and gnashed his teeth. Then he began to speak, quietly and deliberately, picking his words with great care:

'It is Okonkwo that I primarily wish to speak to,' he began. 'But I want all of you to note what I am going to say. I am an old man and you are all children. I know more about the world than any of you. If there is any one among you who thinks he knows more let him speak up.' He paused, but no one spoke.

'Why is Okonkwo with us today? This is not his clan. We are only his mother's kinsmen. He does not belong here. He is an exile, condemned for seven years to live in a strange land. And so he is bowed with grief. But there is just one question I would like to ask him. Can you tell me, Okonkwo, why it is that one of the commonest names we give our children is Nneka, or "Mother is Supreme"? We all know that a man is the head of the family and his wives do his bidding. A child belongs to its father and his family and not to its mother and her family. A man belongs to his fatherland and not to his motherland. And yet we say Nneka—"Mother is Supreme." Why is that?'

There was silence. 'I want Okonkwo to answer me,' said Uchendu.

'I do not know the answer,' Okonkwo replied.

'You do not know the answer? So you see that you are a child. You have many wives and many children—more children that I have. You are a great man in your clan. But you are still a child, *my* child. Listen to me and I shall tell you. But there is one more question I shall ask you. Why is it that when a woman dies she is taken home to be buried with her own kinsmen? She is not buried with her husband's kinsmen. Why is that? Your mother was brought home to me and buried with my people. Why was that?'

Okonkwo shook his head.

'He does not know that either,' said Uchendu, 'and yet he is full of sorrow because he has come to live in his motherland for a few years.' He laughed a mirthless laughter, and turned to his sons and daughters. 'What about you? Can you answer my question?'

They all shook their heads.

'Then listen to me,' he said and cleared his throat. 'It's true that a child belongs to its father. But when a father beats his child, it seeks sympathy in its mother's hut. A man belongs to his fatherland when things are good and life is sweet. But when there is sorrow and bitterness he finds refuge in his motherland. Your mother is there to protect you. She is buried there. And that is why we say that mother is supreme. Is it right that you, Okonkwo, should bring to your mother a heavy face and refuse to be comforted? Be careful or you may displease the dead. Your duty is to comfort your wives and children and take them back to your fatherland after seven years. But if you allow sorrow to weigh you down and kill you, they will all die in exile.' He paused for a long while. 'These are now your kinsmen.' He waved at his sons and daughters. 'You think you are the greatest sufferer in the world? Do you know that men are sometimes banished for life? Do you know that men sometimes lose all their yams and even their children? I had six wives once. I have none now except that young girl who knows not her right from her left. Do you know how many children I have buried—children I begot in my youth and strength? Twenty-two. I did not hang myself, and I am still alive. If you think you are the greatest sufferer in the world ask my daughter, Akueni, how many twins she has borne and thrown away. Have you not heard the song they sing when a woman dies?

'"For whom is it well, for whom is it well?
There is no one for whom it is well."

'I have no more to say to you.'

Daniel Schorr

Call it elitism if you wish, but I find it simply awesome to be admitted into this impressive society of American luminaries. Yet, in candor, I must say that I may be sailing under false colors. Presumably, the

Fellows are chosen to epitomize the professions and disciplines they come from. If I am supposed to represent the world of journalism and communications, this may be a big mistake. Over the years I have developed serious reservations about an industry in which I have worked for the past six decades. I have now come to feel alien to the media that once used to be the Press.

Having experienced journalism in its print, radio, and television incarnations, I have come to mourn the way my beloved profession has become progressively oriented to entertainment, scandal, and profit. I have become aware of increasing public hostility to an institution supposed to monitor the Establishment, but now itself a vast establishment. A public that finds the media insensitive and exploitative is no longer willing to forgive us our press passes.

It is a long way from Hildy Johnson and "Hello, sweetheart, get me rewrite!" to the multimillion-dollar blow-dried television star of today. Sometimes it seems to me that our whole profession is crowded into a small corner of a vast entertainment stage, obliged to borrow the tools and values of entertainment and live by its standards in the grim struggle for ratings that denote profits to the corporate nabobs who now control journalism's destiny.

Daniel Schorr (National Public Radio).

Edward R. Murrow, our idol at CBS, in a famous speech to news directors in 1958, warned that television "insulates us from the realities of the world in which we live." Time has borne him out. From O. J. Simpson to Monica Lewinsky, the media have displayed an inexorable attraction to scandal, along with violence and the hot pursuit of celebrities.

In the rush for ratings, no one is spared. Recently I saw CNN dump out of a live speech by President Bush in order to switch to Los Angeles for the latest word from the sheriff on the investigation of a child kidnapping. I am not aware that the White House even complained about this insult to the presidency.

The Internet has introduced a new dimension of unedited irresponsibility in journalism. Do you remember how the Clinton scandal that led to impeachment first got started? Self-styled gossipmonger Matt Drudge posted on the Web the rumor that *Newsweek* was working on some story about the president and his relationship with an intern. In fact, *Newsweek* was working on a story and holding it for further fact-checking. Drudge didn't see the need for checking. From gossip on the Web, the story quickly escalated to the so-called mainstream media. So a gossipmonger started the ball rolling to impeachment.

Our networks have displayed a willingness to take dictates from the government that once would have been inconceivable. Remember when, in the wake of September 11, National Security Adviser Condoleezza Rice had a conference call with news executives of the five networks and asked them to play down a videotaped statement by Osama bin Laden? They all agreed to do so and were praised by the White House for their patriotism. In the 1930s I heard a lot of Adolf Hitler on the radio. It never occurred to anyone that Americans might be unduly influenced by hearing him.

The definition of "journalist" has changed. A journalist can be a pretty face and pleasant manner of reading from a teleprompter. (A Pew Research Center poll indicated that 77 percent of viewers like news anchors who deliver news in "a friendly

and informal way.") Journalists can be talk-show hosts, skilled at getting guests to yell at each other. A journalist can be a celebrity who came through the revolving door from government. (Of the five Sunday television hosts, two—Bob Schieffer of CBS and Wolf Blitzer of CNN—are career journalists. Three—George Stephanopoulos of ABC, Tim Russert of NBC, and Tony Snow of FOX News—came from government.)

Occasionally, our news media measure up to their responsibility at a time of national tragedy. Television displayed its capacity to bind Americans into a community at moments like the assassinations of John and Robert Kennedy. It reached new heights on September 11, and then on the anniversary of September 11. I was impressed by television's willingness, on those occasions, to cancel millions of dollars' worth of commercials.

But the Ground Zero coverage is the exception. For the rest, I am sad about the state of journalism—a profession I have loved not always wisely, but well. So if you want someone who can speak for the media, you have the wrong fellow.

I hope you don't take my fellowship back. I was just getting to enjoy it.

Edward M. Kennedy

The Academy was founded two centuries ago in the tradition of the highest ideals of our young democracy. John Adams, John Hancock, and others established this distinguished community of ability and ideals—a place where the best minds could convene and recommend measures to improve public policy and benefit the lives of all our citizens. They envisioned an American center for the arts and sciences, and I know that they would be very pleased today with the Academy's achievements.

President Kennedy was proud to be inducted into the Academy in 1955. Years later, at the White House, he hosted a dinner honoring Nobel Prize winners of the Western Hemisphere. In welcoming

Edward M. Kennedy (US Senate).

his guests that evening, he said, "I think this is the most extraordinary collection of talent, of human knowledge, that has ever been gathered together at the White House, with the possible exception of when Thomas Jefferson dined alone." Jack would say the same thing, I'm sure, about the Academy today.

This Academy was founded at a time of great uncertainty and challenge. Important as that challenge was for our country, the founders understood that America could not afford to neglect the arts and humanities in the nation's life. Our literature and poetry, our music and dance, our paintings and sculpture help to define us as a people. They are not an extension of our national life; they are its expression.

As Adams said, "I must study politics and war that my sons may have the liberty to study mathematics and philosophy . . . in order to give their children the right to study painting, poetry and music."

Much has been written of Adams in recent years. Thanks in large part to David McCullough, the nation's second president has earned a prominence and respect that even he could not have imagined. His vision so many years ago is at the very heart of American values today. We study his writings and aspire to his example. As future generations of Americans look back on this time in our history,

we want them to know that we too had the courage and wisdom to meet the challenges of our day—that we defended the principles of democracy and freedom, and preserved our founding ideals and our national sense of purpose.

Today we face a new threat of war, one that will change the way America is viewed by its allies and adversaries. The question of whether our nation should attack Iraq is playing out in the context of a more fundamental debate that is only just beginning—an all-important debate about how, when, and where in the years ahead our country will use its unsurpassed military might.

In September the Bush administration unveiled its new National Security Strategy. This document addresses the new realities of our age, particularly the proliferation of weapons of mass destruction and terrorist networks armed with the agendas of fanatics. The Strategy claims that these new threats are so novel and so dangerous that we should "not hesitate to act alone, if necessary, to exercise our right of self-defense by acting preemptively."

The administration's discussion of self-defense often uses the terms "preemptive" and "preventive" interchangeably. However, in the realm of international relations, these two terms have long had very different meanings.

Traditionally, "preemptive" action refers to times when states react to an imminent threat of attack. For example, when Egyptian and Syrian forces mobilized on Israel's borders in 1967, the threat was obvious and immediate, and Israel felt justified in preemptively attacking those forces. The global community is generally tolerant of such actions, since no nation should have to suffer a certain first strike before it has the legitimacy to respond.

By contrast, "preventive" military action refers to strikes that target a country before it has developed a capability that could someday become threatening. Preventive attacks have generally been condemned. For example, the 1941 sneak attack on Pearl Harbor was regarded as a preventive strike by

Japan, because the Japanese were seeking to block a planned military buildup by the United States in the Pacific. The coldly premeditated nature of preventive attacks and preventive wars makes them anathema to well-established international principles against aggression. Pearl Harbor has been rightfully recorded in history as an act of dishonorable treachery.

Historically, the United States has condemned the idea of preventive war, arguing that it violates basic international rules against aggression. But at times in our history, preventive war has been seriously advocated as a policy option.

In the early days of the cold war, some US military and civilian experts advocated a preventive war against the Soviet Union. They proposed a devastating first strike to prevent the Soviet Union from developing a threatening nuclear capability. At the time, they said the uniquely destructive power of nuclear weapons required us to rethink traditional international rules.

That debate ended in 1950, when President Truman ruled out a preventive strike, arguing that such actions were not consistent with our American tradition. He said, "You don't 'prevent' anything by war . . . except peace." Instead of a surprise first strike, the nation instead dedicated itself to the strategy of deterrence and containment, which successfully kept the peace during the long and frequently difficult years of the cold war.

The argument that the United States should take preventive military action in the absence of an imminent attack resurfaced in 1962, when we learned that the Soviet Union would soon have the ability to launch missiles from Cuba against our country. Many military officers urged President Kennedy to approve a preventive attack to destroy this capability before it became operational. Robert Kennedy, like Harry Truman, felt that this kind of first strike was not consistent with American values. He said that a proposed surprise first strike against Cuba would be a "Pearl Harbor in reverse." "For 175 years," he said, "we have not been that

kind of country." That view prevailed. A middle ground was found, and peace was preserved.

As these two cases show, American strategic thinkers have long debated the relative merits of preventive and preemptive war. Although nobody would deny our right to preemptively block an imminent attack on our territory, there is disagreement about our right to preventively engage in war.

The circumstances of our new world require us to rethink this concept. The world changed on September 11, and all of us have learned that it can be a drastically more dangerous place. The Bush administration's new National Security Strategy asserts that global realities now legitimize preventive war and make it a strategic necessity.

The document openly contemplates preventive attacks against groups or states, even absent the threat of imminent attack. It legitimizes this kind of first-strike option, and it elevates it to the status of a core security doctrine. Disregarding precedents of international law, the Bush strategy asserts that our unique military preeminence exempts us from the rules we expect other nations to obey.

I strongly oppose any such extreme doctrine, and I'm sure that many of you do as well. Earlier generations of Americans rejected preventive war on the grounds of both morality and practicality, and our generation must do so as well. We can deal with Iraq without resorting to this extreme.

It is impossible to justify any such double standard under international law. Might does not make right. America cannot write its own rules for the modern world. To attempt to do so would be unilateralism run amok. It would antagonize our closest allies, whose support we need to fight terrorism, prevent global warming, and deal with many other dangers that affect all nations and require international cooperation. It would deprive America of the moral legitimacy necessary to promote our values abroad. And it would give other nations an excuse to violate important principles of civilized international behavior.

The administration's doctrine is a call for twenty-first-century American imperialism that no other nation can or should accept. It is the antithesis of all that America has worked so hard to achieve in international relations since the end of World War II.

Obviously, the debate is only just beginning on the administration's new strategy for national security. But the debate is solidly grounded in American values and history. I know that all of you in this distinguished Academy will be part of it, and I look forward to your contributions.

It will also be a debate among vast numbers of well-meaning Americans who have honest differences of opinion about the best way to use US military might. The debate will be contentious, but the stakes—in terms of both our national security and our allegiance to our core beliefs—are too high to ignore.

On this and on so many other challenges we will face in the months and years ahead, I know that this Academy will help us all to live up to the ideals established by the founders of our country two centuries ago.

Global Climate Change and the Making of a Report to the President of the United States

Ralph J. Cicerone, Aldrich Professor of Earth System Science and Chancellor, UC Irvine

Commentary: ***F. Sherwood Rowland,*** Donald Bren Research Professor of Chemistry and Earth System Science, UC Irvine

Ralph J. Cicerone

In the spring of 2001, the White House asked the National Academy of Sciences (NAS) to conduct a study on the reality and seriousness of climate change. The request was unusual in two respects. First, the White House does not routinely make requests of the NAS; requests typically come from federal agencies, state governments, and corporations. Second, the amount of time the White House gave the NAS to conduct the study was very small. When Bruce Alberts received the request from White House staff and told them that the normal turnaround time for an NAS study was between nine and twenty-four months, he was shocked when they responded, "How about three weeks?" Bruce and his confidantes inside the NAS really did not know what to do, so they did not accept the request at first—but the situation turned around very quickly during the first week of May. Bruce asked me if I would chair the panel to do the study—a panel that had yet to be created. I said, "Yes, it's worth a try." Others agreed: all of the people we asked to serve on the committee, including

This presentation was given at the 1860th Stated Meeting, held at the Beckman Conference Center in Irvine, California, on May 18, 2002.

Commentator F. Sherwood Rowland and speaker Ralph J. Cicerone (both, UC Irvine).

Professor Rowland, were willing to drop what they were doing in order to participate.

Our study report responded to thirteen direct questions from the White House. Part of the deal was that we were to give the White House a briefing before the report was released so that they could factor it into their views as soon as possible. After the document had been peer-reviewed anonymously by thirteen people, Professor Rowland and I went to the White House and delivered it, on time, early in June 2001. Two days before that, in a conference call, I gave the White House a very long briefing on the contents. Getting to that point was really a story in itself—in some ways a dramatic and tense one.

We didn't know at the time that the White House was preparing to take its position on the Kyoto Protocol. The United Nations had established a framework convention on climate change in 1992, which was signed by the previous President Bush after an international meeting in Rio de Janeiro. One of the stated goals of that framework convention was to "prevent the dangerous manmade interference with the climate system." Over the subsequent eight years, a number of other interna-

tional meetings were held, including one in December 1997 in Kyoto, where the framework convention became more specific as to what the signatory nations would have to commit to in limiting the emissions of various gases and other substances into the atmosphere. As I say, we didn't know that the new Bush administration, in May and June of 2001, was preparing to make its own decision. But we were told, just as we started this study that May, that we had been given an extremely short period of time because the president needed our report for a trip to Europe in June. As it turned out, he traveled to Sweden and Germany. Later that summer, the United States government withdrew from the Kyoto Protocol.

The study committee decided simply to respond to the questions from the White House without editorializing, to stay as close to the subject as we could, and to make no comments whatsoever about the political and economic aspects of climate change. And that is what we did.

The first question, which I will dwell on for a couple of minutes, was *"What is the range of natural variability in climate*?*"* That is a suitable and intelligent question, and it also has a practical impact. That is, if climate change is occurring, the next questions might be, Is it natural? Are there alternative ways to explain it besides simply blaming it on human activities? Another question was, *"Are the concentrations of greenhouse gases that contribute to climate changes increasing in the atmosphere?"* One question with some policy relevance was, *"How long does it take to reduce the buildup of greenhouse gases once they are in the atmosphere?"* Another was, *"Is climate change occurring and, if so, how?"*

Climate change has characterized Earth over its entire history. For example, an inland continental glacier—say, in the Peruvian Andes—consists of horizontal layers of ice formed by the annual deposition of snow, which becomes compressed. In certain formations, where the ice has been preserved, one can actually count the layers by drilling cylindrical cores out of the ice. More important,

those samples can be brought into laboratories under freezing conditions and analyzed. There are a couple of places in Antarctica now where the ice cores represent four hundred thousand years of record—not only of past climate change but also of what was in the air at the time. Gases can be extracted from the layers, which makes it possible to reconstruct histories of the composition of the air and to determine what greenhouse gases were present. Of course, there is plentiful geological evidence of large periods of glaciation, when more than half of North America was covered by very deep glacier, and of other periods when Earth was much warmer. Certainly, climate change has occurred in the past, and the range of natural variability is reasonably large. We pointed that out in our report.

As to whether concentrations of greenhouse gases are increasing, the answer, of course, is yes. For 45 years, Professor Charles Keeling and colleagues from several organizations have measured the amount of carbon dioxide in the air in various locations around the world. Professor Keeling started his own work on this topic in 1957 in Hawaii, and the record shows a continuous increase of atmospheric amounts of carbon dioxide. Beginning in the late 1950s, the carbon dioxide levels were 310 to 312 parts per million, on average, with beautiful seasonal cycles that tell us a great deal about photosynthesis and respiration on the entire planet, as well as the global cycling of the nutrient element carbon. Over the 45-year period that followed, levels of carbon dioxide—the principal human-caused greenhouse gas—increased to 370 parts per million. Scientists have also measured past methane amounts by using dated ice cores. Since 1800, with the start of the Industrial Revolution, one sees a dramatic rate of increase in the amounts of carbon dioxide, methane, nitrous oxide, and even sulfur (which is not a greenhouse gas) in the air. The record of sulfate deposited in ice cores actually helps us to unravel whether current climate change is due to human activity or to something natural. The question of whether concentrations of greenhouse gases are increasing was the easiest one the White House asked, because we

have tons of high-quality data collected by many scientists over the past 40 years. We also know that the carbon dioxide increase in the past century is 75 to 80 percent due to our burning of fossil fuels—that is, fuels that contain carbon (e.g., oil, wood, coal, natural gas, petroleum)—and about 20 to 25 percent due to the deforestation of basically tropical lands, mostly for agricultural purposes. The deforestation not only causes the wood to be burned; it also causes a loss of organic matter that had accumulated in the soil over thousands of years, which becomes oxidized and is released to the atmosphere in the form of carbon dioxide.

In the case of methane, we have determined that on an annual basis, roughly one-third of the amount present in the air comes from completely natural sources that have been producing methane more or less steadily for thousands of years. But two-thirds of the methane emitted annually is under human control or at least human influence. For example, large amounts of methane are released out of both ends of domesticated cattle. Natural gas distribution, coal mining, municipal landfills, and rice agriculture are other sources. That atmospheric methane levels have increased by more than a factor of two since the Industrial Revolution reflects the extra added human input compared with what was previously totally natural.

It was harder to answer this question: *"Is climate change occurring and, if so, how?"* We analyzed

Left to right: Jack Peltason (UC Irvine), Suzanne Peltason, Mari Choper, J. Hillis Miller (UC Irvine), and Jesse Choper (UC Berkeley).

temperature measurements taken over the past 120 years all around the world, over land and ocean, at all points—probably about 200 million observations of temperature at Earth's surface, taken from ships and weather stations. Very dramatic upward excursions of air temperatures have occurred in the past 20 years. There was warming from about the beginning of the twentieth century until around 1940. Then there was a slight cooling until the year 1975, and rapid warming afterwards, with a total excursion of about six-tenths of a degree Centigrade, or one degree Fahrenheit, of warming over the past century. This is one measure of climate change, but in reality, the variables of climate that we should really be concerned about are not average temperatures. The variables that will affect us and all life around us are extreme temperatures, extreme drought, extreme storms—not average temperatures. Nevertheless, the average temperature measure leads to other questions: Given that there has been this kind of warming over the past hundred years, are greenhouse gases causing climate change? By how much will temperatures change over the next hundred years, and where?

A very interesting question posed by the White House was this one: *"Has science determined whether there is a safe level of greenhouse concentrations?"* After a few days, I realized that the reason for that question was that the intention of the United Nations framework convention was to prevent dangerous levels of greenhouse gases. It turns out that we cannot give a very clear answer to this question. Depending on the amount of climate change and its rapidity, greenhouse gases could reach levels that would endanger poor countries and island nations far earlier than modern industrial societies. Nations that are well equipped with technology, that have the ability to foresee the change, and that have the capital and the scientific and technological ability to take mitigating action (e.g., providing the right kind of irrigation for agriculture, or levies against seawater intrusion in water-treatment plants, as in New Orleans) can ac-

commodate a certain amount of climate change if it happens slowly enough.

The Sun itself may be changing. In the past twenty years, the global average temperature has risen rather quickly—faster than at any other time in the previous hundred years. The temperature increase and the rate of this change are so large that many scientists began to think, a few years ago, that they were probably due to human activities; the rate of change pretty much repeats what was predicted from the greenhouse gases. But it is still possible that the rise in temperature may be a natural effect of some kind. The most likely natural explanation would be a change in output from the Sun during the past twenty years, but we must also consider that the past twenty years is the first period of time in which humans have measured the output of the Sun carefully enough to be able to tell whether it is changing. Judith Lean and her colleagues at the Naval Research Laboratory have reported an extremely precise set of measurements. They found that the Sun's total output varied over an eleven-year cycle, as people thought it did, and that after twenty-two years, the Sun's output returned to the level at which it had started. In fact, it was slightly lower, but insignificantly so. Thus, any suggestion that the warming of the past twenty years has a natural cause—especially increasing output from the Sun, the best hypothesis that people had invented—is simply not tenable. Scientists are now facing the reality of human-caused warming and grappling with the question of what will happen in the future.

Judging by probable estimates made by the Intergovernmental Panel on Climate Change (IPCC)—a group of about a thousand scientists who have been working over the past ten years to assess our state of knowledge—we can expect to see higher maximum temperatures and more hot days over nearly all land areas, with higher minimum temperatures and fewer cold days and frost days over all land areas. There will probably be a warming of the centers of the continents and an earlier drying out of soils after snow melts in the spring in

Left to right: Albert Bennett (UC Irvine), Kimball Romney (UC Irvine), Pauline Skyrms, and Brian Skyrms (UC Irvine) with speaker Ralph J. Cicerone.

agricultural belts in North America, Canada, and Russia. These projections are based on physical reasoning as well as computer models. What is likely to happen over the next hundred years, assuming a "business as usual" environment in which we continue to increase our rate of fossil fuel consumption and methane production? The IPCC predicts that by the end of the next century, the temperature increase will be somewhere between five and a half degrees Centigrade on the high side and about two degrees Centigrade on the low side, depending on the number of people in the world, as well as such factors as their fuel use, lifestyles, and levels of affluence.

Our report to the White House was very difficult to write because there are so many uncertainties and we do not yet know how to predict climate change in enough detail. We started with simple statements that we were able to make in direct answer to the questions posed, and we qualified our other statements. Greenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise—but we cannot rule out that some significant part of these changes is also a reflection of natural variability.

As you know, the Bush administration decided to end its participation in the Kyoto Protocol. I think that was a mistake because we have lost our influence to modify the treaty and because we are for-

feiting future markets in energy technologies, among other reasons. We found out, in the process of preparing our report and during some summer testimony in the House and Senate, that the members of the administration, both in the White House and in the Cabinet, are divided on how to address humankind's impact on climate change. Some of them are taking this issue very seriously and, I believe, want the administration to stay involved internationally. Several other individuals moved in the opposite direction and took President Bush with them. They have all looked at the situation very carefully; they simply disagreed with each other.

F. Sherwood Rowland

On the morning of June 6 last year, half an hour before we were scheduled to brief the State Department on our National Academy of Sciences report on "The Science of Climate Change," we were looking closely at the just-arrived printed version of the document, and we noticed that a certain paragraph wasn't quite right. So we sent the report back for reprinting with the revisions, and the State Department briefing was conducted without any accompanying printed material. Then, after lunch, just before Ralph and I were to go over to the White House with the final report, a reporter for the *New York Times* called the NAS press office to request an advance copy before the press conference scheduled for the following morning. He was told, "No, you can't have it. That's our policy." However, the reporter had already learned that a briefing for members of Congress was going to happen immediately after the White House session, and he said, "If I don't get a copy from you, I'll have one from Congress by five o'clock this afternoon, and you won't have to worry about a press conference tomorrow." Of course, he would certainly have obtained a copy by that route. So that afternoon, while other committee members and I briefed the congressmen, Ralph was not with us. Instead, he was talking with the *Times* reporter and with other journalists who had been calling. The lead story on the

front page of the *New York Times* the next morning revealed the conclusions that Ralph has just talked about here: that global temperatures are rising, and that human activities are among the most important causes of this phenomenon.

In my short commentary, I want to emphasize the importance of discriminating between the greenhouse effect and its enhancement. Many people think that the whole concept of the greenhouse effect is controversial, but it is not. Its existence and its causes are both understood and accepted in the scientific community. Current discussions center on how much the greenhouse effect may be increased during the coming decades, not on its validity.

The amount of solar energy that reaches Earth has to be balanced closely, on a day-to-day basis, by an equal amount of energy escaping from Earth. When scientists talk about global warming, they are concerned about a one- to three-degree temperature increase accumulated over the next fifty years—an imperceptible daily imbalance between the incoming and outgoing energies. The total energy radiated by both the Sun and Earth is basically determined by the surface temperature of each, as are the wavelengths of the emitted radiations. The energy emitted by the Sun as a consequence of its surface temperature of 5,800 degrees Kelvin is given off chiefly in the visible wavelengths corresponding to the colors red through violet, and in the invisible wavelengths of the near infrared and of the ultraviolet. The energy leaving Earth is emitted at much longer wavelengths in the far infrared, as determined by our surface temperature of about 57 degrees Fahrenheit, or 287 Kelvin.

The amount of energy absorbed by Earth is determined by the intensity of energy emission from the Sun, the distance of Earth from the Sun, and the albedo of Earth—the portion (about 30 percent) of the solar radiation that is reflected from Earth back into space without absorption. A straightforward calculation can be performed of the needed temperature for Earth's surface for the emission of an equivalent amount of far infrared energy if the

President Patricia Meyer Spacks (University of Virginia), Executive Officer Leslie C. Berlowitz, and Western Center Cochairs Walter Fitch (UC Irvine) and John Hogness (University of Washington) at a meeting of the Western Center Executive Council, held prior to the Stated Meeting.

additional assumption is made that *all* of this far infrared radiation escapes directly to space. When this calculation is performed, the needed surface temperature for Earth is 0 degrees Fahrenheit, far below the actual circumstance. The 57-degree difference between this calculated temperature of 0 degrees Fahrenheit and the actual average Earth temperature of 57 degrees Fahrenheit is the natural greenhouse effect. The reason for this large discrepancy is well understood: not all of this terrestrially emitted infrared radiation actually escapes to space. And the cause of this blockage of infrared escape is the presence in the atmosphere of the greenhouse gases.

The important greenhouse gases are those atmospheric components which have three or more atoms per molecule: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3), and water (H_2O), plus others, such as the chlorofluorocarbon gases, or CFCs (CCl_2F_2, CCl_3F, etc.). Significant amounts of these gases entering the atmosphere arise from the activities of humankind. Each of these molecular forms has the ability to absorb

some infrared radiation at particular wavelengths in the far infrared while remaining transparent to other nearby wavelengths. (For this reason, the infrared spectrum of a molecule can be used as a "fingerprint" of its presence.) When the infrared energy at some wavelengths fails to escape, the response of Earth is to warm up until the additional energy escaping through the transparent regions of the spectrum equalizes for the shortfall in the regions of radiation absorption. This interception of outgoing terrestrial radiation in the wavelengths associated with the individual greenhouse gases has been amply confirmed by Earth-orbiting nadir-focused satellites.

The question is not whether there is a greenhouse effect in the atmosphere; rather, it is how much that effect will be enhanced by the growing concentrations of carbon dioxide, methane, and other greenhouse gases. The amount of water vapor in the atmosphere is basically controlled by the temperature of the oceans: if greenhouse absorption by the other gases causes the surface temperature to begin to rise, this increase will cause more water to evaporate, raising its concentration in the atmosphere and trapping still more of the outgoing infrared radiation. This is an example of a positive feedback to the overall temperature increase. Other positive feedbacks occur when snow melts, exposing bare ground, and when floating ice melts, leaving a surface of open water in its place. In both instances, the substitution reduces the albedo over the affected region; less solar radiation is reflected to space, and more remains to warm the planet. The question for the coming century is whether the natural greenhouse effect of 57 degrees Fahrenheit will be enhanced through the additional accumulation of greenhouse gases, and by the actual magnitudes of the various feedback processes, to 59 or 60 or 63 degrees Fahrenheit. That quantitative question is more difficult to answer than the yes/no question of whether there is a greenhouse effect, which has already been answered in the affirmative.

Both Ralph's research group and mine have been much involved, over the years, in studying the

atmospheric characteristics of methane—the second most important greenhouse gas after carbon dioxide. Ralph and his colleagues have established, for instance, that the methane that comes out of rice paddies when they are flooded escapes by coming up through the rice plant itself, going directly into the atmosphere rather than escaping as bubbles rising through the water. My research group started measuring globally the amounts of methane back in 1978 and has monitored the atmospheric composition since by sampling every three months at locations from Point Barrow, Alaska, to the southern tip of New Zealand. During the 1980s we found a rather steady increase of about 1 percent per year in the total amount of methane in the atmosphere. During the 1990s, however, the increase was more erratic, fluctuating over time scales of one or two years between an increase of 1 percent per year and no increase at all. We do not yet have a good understanding of all the causes for the fluctuations. My own hunch is that an important contributing factor was the collapse of the Soviet Union and thereby of the demand for its abundant resources of natural gas.

The last two decades have shown definite evidence that Earth is warming. The year 2001 was the second-warmest year in the long interval since

Academy Visiting Scholar Ann Marie Mikkelsen and her husband, Daniel Sharfstein, were introduced at the Stated Meeting.

temperatures have been widely enough measured geographically to provide a usable global average—a period of record that began about 1860 to 1870. The year 1998 was the hottest one in that record, and the 1990s have been the warmest decade, despite a two-year global temperature reduction caused early by the 1991 eruption of Mount Pinatubo in the Philippines. That volcanic explosion put enough sulfur into the stratosphere to form a layer of sulfuric acid that temporarily increased the planetary albedo, reflecting additional amounts of the incoming solar radiation to space for about two years. The total temperature increase since about 1860 has been slightly more than one degree Fahrenheit, with about half of this increase occurring over the past two decades.

I will close with just one other comment. Only a week or so before we delivered the report on global climate change to the White House, there was a very good chance that the consensus of the NAS committee was going to fall apart as a result of arguments and disagreements about particular points. The real feat that Ralph pulled off—getting everybody on board for the final version, as published—required a lot of hard work and careful persuasion on his part. The final production of a unanimous, successful report was a tribute to his chairmanship. All of us should be thankful that Ralph was the chairman of that committee.

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FORTHCOMING STATED MEETINGS

House of the Academy

February 12, 2003

Gerald Early (Washington University in St. Louis) on "Art, Race, and the Coldest War: The Image of the African American Soldier in Three Hollywood Korean War Films"

March 12, 2003

Program: "A Tribute to Herman Feshbach and Victor Weiskopf"

Speaker: Steven Weinberg (University of Texas, Austin)

April 10, 2003

Joint Meeting of the Academy and the Boston Athenaeum

Speaker: Patricia Meyer Spacks (University of Virginia)

May 14, 2003

Annual Meeting

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