

PHYSICS & SOCIETY

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EDITOR'S COMMENTS

With the passing of Wolfgang (“Pief”) Panofsky, this newsletter has lost a great friend and contributor. Starting a few years ago, Pief would occasionally invite me (JJM) to his office at SLAC for a “brown bag lunch,” during which we would discuss issues of interest to readers of *Physics & Society*. Sometimes, Pief would also suggest a series of articles for the newsletter. The following three series resulted directly from his suggestions during our “brown bags”:

1. The dangers of nuclear weapons after the Cold War (published in P&S October 2003 thru January 2005)
2. Science advice and executive policy formulation (October 2005, October 2006, January 2007)
3. What are nuclear weapons for? (starting in October 2007)

Pief suggested not only topics but also authors qualified to write on those topics. Through Pief, and with the invaluable assistance of his administrative assistant Ellie Lwin, I recruited several members of Stanford University’s Center for International Security and Cooperation (CISAC) to write for our series starting in 2003 and continuing to this day. In addition, Pief himself contributed articles to P&S during that time period, as a glance at the Tables of Contents will show.

Two of the more memorable times that I had with Pief include the time when he showed off to me his brown bag, made not out of paper but of plastic made to look like a brown paper bag. He’d been using it for years, and it was clearly environmentally superior to traditional brown bags since it

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EDITOR'S COMMENTS

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What Are Nuclear Weapons For? *John S. Foster, Jr. & Keith B. Payne*
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- Three Inconvenient Truths, *Robert Ehrlich*

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- Out of the Shadows: Contributions of Twentieth-Century Women to Physics, Edited by Nina Byers and Gary Williams, *Reviewed by Marty Epstein*
God: The Failed Hypothesis — How Science Shows That God Does Not Exist, by Victor J. Stenger, *Reviewed by Lawrence S. Lerner*

NEWS OF THE FORUM

Short Course on Energy

Physics of Sustainable Energy: Using Energy Efficiently and Producing It Renewably

Saturday/Sunday, March 1–2, 2008, University of California at Berkeley

Sponsors: APS–Forum/Phys–Society, AAPT

The US continues to import oil from the unstable Middle–East. The European Union calls for a 50% reduction in carbon by 2050 and California with 20% by 2020. How will this be done? The short course will be held in Evans Hall (room 10) at UC Berkeley. This is a chance to learn from 22 of the US’s leading experts. It is intended to give physicists in–depth technical background needed to evaluate these issues for teaching and research. Conference sponsor is the APS Forum on Physics and Society; D. Hafemeister (CalPolyU), B. Levi (Physics Today), M. Levine (LBNL) and P. Schwartz (CalPolyU). The \$100 admission fee includes two lunches and 500 page AIP Conference Proceedings, +\$35 for banquet, UC Faculty Club. **DON’T PROCRASTINATE, ATTENDANCE IS LIMITED.** See www.calpoly.edu/~dhafemei/APSenergy.html.

I. Overview on Energy Issues (*Saturday, March 1, 8:30 AM*)

- 1 Science of Photons to Fuels (Steve Chu, LBNL)
- 2 Energy End-Use Efficiency (Art Rosenfeld, CEC)
- 3 US–China Energy Issues (Mark Levine, LBNL)
- 4 Carbon Reduction Wedges (Rob Socolow, Princeton)
- 5 Science and Policy for Deep Cuts in Carbon Emissions (Dan Kammen, UCB)

Lunch

II. Energy-Use in Buildings and Industry

- 1 Buildings as Systems (Danny Harvey, U. Toronto)
- 2 Physics of Buildings (David Hafemeister, CalPoly)
- 3 Windows and Daylighting (Steve Selkowitz, LBNL)
- 4 Appliance Designs and Standards (Jim McMahon, LBNL)
- 5 Lighting, the white LED (Steve DenBaars, UCSB)
- 6 Heating/Ventilation/Airconditioning (Craig Wray, LBNL)
- 7 Industrial Use of Energy (Lyn Price, LBNL)

Banquet, Art Rosenfeld, “A day in the life of an Energy Commissioner,” Berk. Fac. Club (\$35)

III. Energy–use by Automobiles (*Sunday, March 2, 8:30 AM*)

- 1 The Race for 21st Century Auto Fuels (Alex Farrell, UCB)
- 2 Safe Automobiles (Tom Wenzel-LBNL, Marc Ross-UMichigan)
- 3 Plug in Electric Cars and the Grid (Mark Duvall, EPRI)
- 4 Batteries for Electric Cars (Venkat Srinivassen, LBNL)
- 5 Hydrogen for Vehicles (Jan Herbst, GM)

Lunch

IV. Electricity Production

- 1 Solar Photovoltaics (Michael McGehee, Stanford)
- 2 Concentrating Solar Power (Mark Mehos, NREL)
- 3 Wind (Robert Thresher, NREL)
- 4 Nuclear Power (Per Petersen, UC-Berkeley)
- 5 Carbon Capture and Sequestration (Larry Myer, CEC)
- 6 Electrical–Grid Energy Storage (John Hull, Boeing)

Name _____

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____ \$100 check to APS (+ parking \$15/d, banquet \$35)

____ \$80 Student (licenses plate _____)

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ARTICLES

You Say You Want an Evolution? A Role for Scientists in Science Education

Coalition of Scientific Societies¹

Abstract: *We conducted a national survey of likely U.S. voters to examine acceptance of evolution, attitudes toward science and scientists, and opportunities for promoting science education. Most respondents accepted that life evolved, many accepted that it evolved through natural processes, and more favored teaching evolution than creationism or intelligent design in science classes. The majority ranked developing medicines and curing diseases as the most important contributions of science to society, and they found promoting understanding of evolutionary science's contribution to medicine to be a convincing reason to teach evolution. Respondents viewed scientists, teachers, and medical professionals favorably, and most were interested in hearing from these groups about science, including evolution. These data suggest that the scientific community has an important role to play in encouraging public support for science education.*

Role for Scientists in Science Education

Although evolution is firmly established as one of the most important, integrative, and robust concepts in science, teaching evolutionary science and related subjects (e.g., the origins of the universe, the age of the earth, plate tectonics) has been challenged in school districts across the United States. These challenges—whether introducing religious beliefs as “alternatives” to science, labeling evolution or the big bang as “theory, not fact,” or singling out scientific subjects for “critical analysis”—jeopardize science education. Recognizing the harm such actions pose to science education and, ultimately, to the foundation on which scientific advancement is based, 17 scientific societies, representing the physical, chemical, biological, and social sciences and science teachers communities, established an unprecedented coalition to explore opportunities for collective understanding and action. As part of this effort, we engaged a professional research firm to conduct a national survey of approximately 1,000 likely U.S. voters (1) that examined attitudes toward science and scientists, views on evolutionary science in the context of education, and means through which the scientific community can effectively bolster support for teaching evolution and related subjects.

Recent studies show that Americans' views on evolutionary science have been relatively stable over the past several decades. Beginning in the 1980s, polls consistently found that between approximately 40% and 50% of the American

public accepts human evolution (2-3), and 40% to 50% favors a Biblical creationist account of the origins of life (3). An analysis by the Pew Research Center shows that Americans' views on evolutionary science vary with the phrasing of the question, however (3). For example, when people are asked to choose whether humans developed over millions of years either with or without guidance from God (a Gallup poll question), more select evolution with guidance (38%) than without guidance (13%). A Pew poll question shows a different pattern of results. Respondents were first asked, without reference to a supreme being, if they thought humans evolved or were created in their present form. Those who accepted evolution were then asked if they thought it occurred through natural processes or with guidance. When asked this way, 18% reported that evolution occurred with guidance and 25% accepted that it occurred through natural selection.

We anticipated that acceptance of evolutionary science would also be influenced by the distinction between human and non-human species (Fig. 1). We asked half of the respondents about their views on the evolution of “all living things” and found that 61% accepted that “all living things have evolved over time.” Of those, 36% thought all living things “evolved due to natural processes such as natural selection” and 25% thought “a supreme being guided the evolution of living things for the purpose of creating life in the form it exists today.” We asked the remaining respondents to consider

¹*American Association of Physics Teachers, American Astronomical Society, American Chemical Society, American Institute of Biological Sciences, American Institute of Physics, American Physical Society, American Physiological Society, American Society for Investigative Pathology, American Society for Pharmacology and Experimental Therapeutics, American Society of Human Genetics, Biophysical Society, Consortium of Social Science Associations, Geological Society of America, Federation of American Societies for Experimental Biology, National Academy of Sciences, National Science Teachers Association, Society for Developmental Biology*

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human evolution and found that 53% accepted that “humans and other living things” evolved. This majority included 32% who accepted that humans and other living things evolved through natural processes and 21% who thought they had evolved with guidance. Compared to other surveys (3), we found weaker overall support for creationism: 28% and 31% agreed with statements that “all living things” or “humans and other living things,” respectively, were created in their present form. Sixteen percent of respondents who were asked about the evolution of “humans and other living things” and 11% of those asked about the evolution of “all living things” did not know or would not disclose their views.

Although public opinion is often characterized as polarized, there is considerable uncertainty about what to teach in public school science classes, particularly with regard to including certain religious perspectives. Thirty-two percent of respondents in our study were unsure about teaching creationism and 41% were uncertain about teaching intelligent design. By comparison, 22% expressed uncertainty about teaching evolution. Consistent with other studies (5), however, more respondents favored teaching evolution (53%) than creationism (36%) or intelligent design (27%) in public school science classes. These data show that a majority of people favor—and even more may be open to—teaching evolution in science classes.

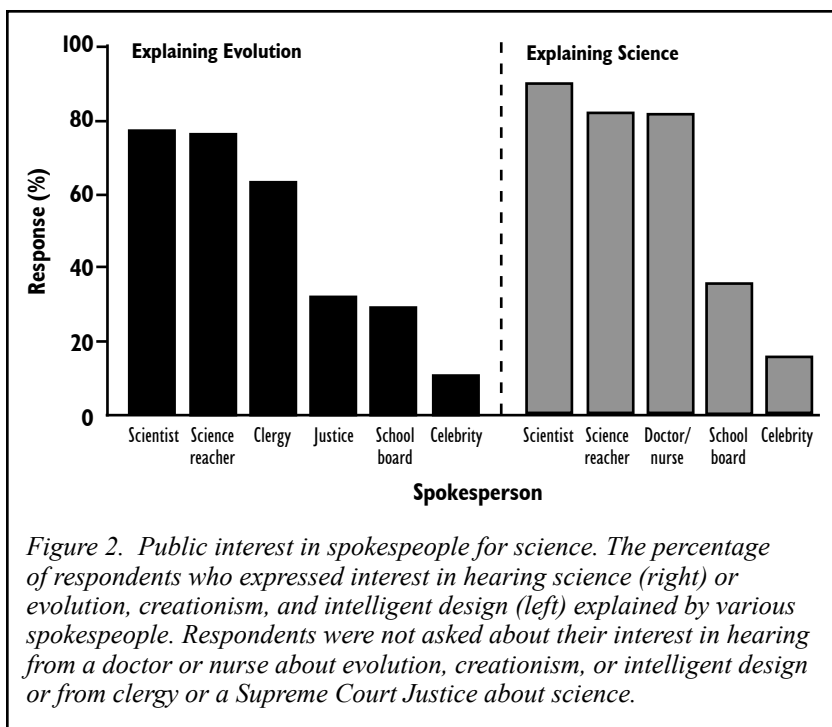
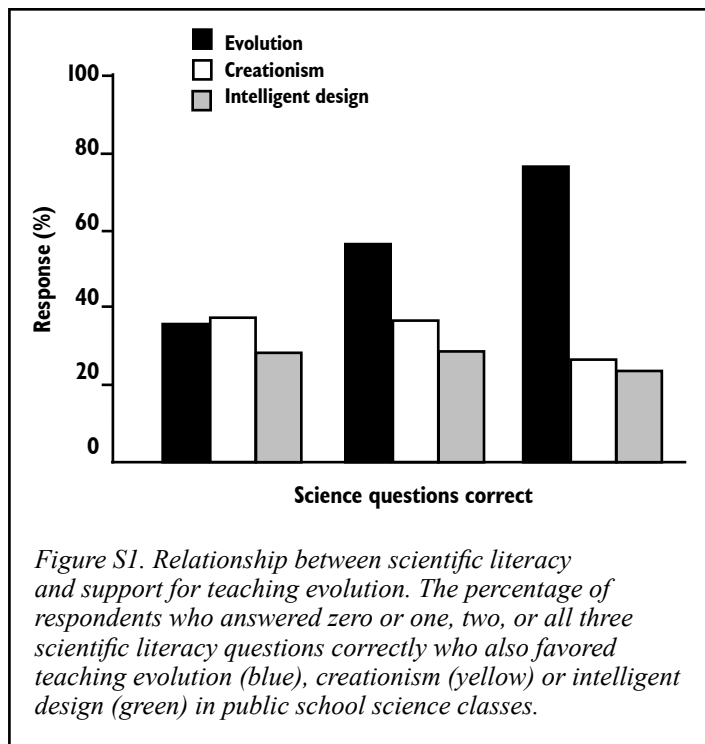
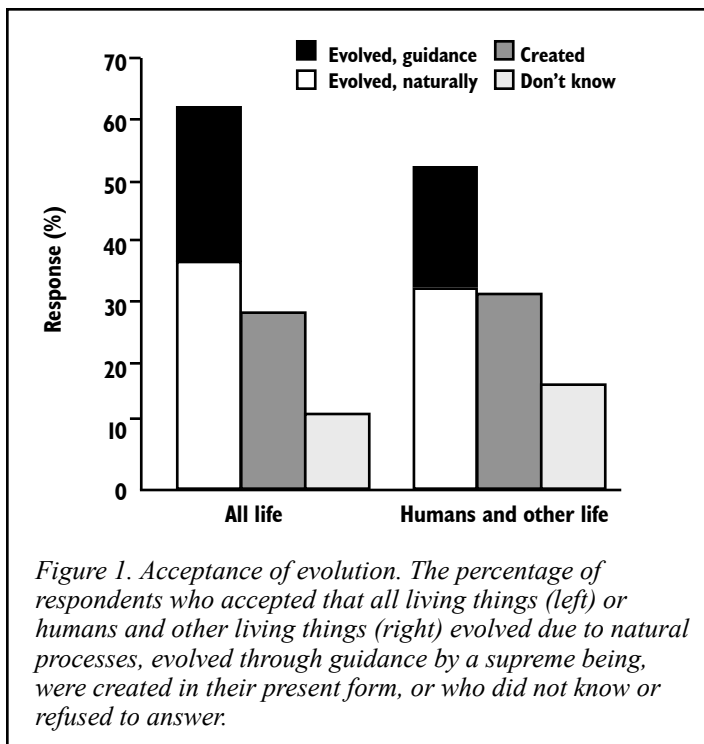
Why don't more Americans accept evolutionary science? A recent study shows that acceptance is negatively correlated with fundamentalist religious beliefs and politicization of science and positively correlated with genetics literacy (2). While we did not examine genetics literacy in particular, we did find a connection between respondents' views on evolution education and their answers to three scientific questions (Fig. S1). Although 69% of survey participants had some college education (27% were college graduates and 14% had attended graduate school), only 23% gave correct responses to all three of the following statements: the continents or land masses on which we live have been moving for millions of years and will continue to move in the future (79% correctly agreed); antibiotics kill viruses as well as bacteria (43% correctly disagreed); the earliest humans lived at the same time as the dinosaurs (53% correctly disagreed). Respondents who answered all three questions correctly were much more likely to respond that humans and other living things evolved (78%) than that they were created in their present form (11%), and more favored teaching evolution (78%) than creationism (27%) or intelligent design (24%). In contrast, respondents who answered fewer than two questions correctly were less likely to accept that life evolved (36%) than to believe it was created in its present form (47%), and they were about as likely to favor teaching evolution (36%) as creationism (38%) and intelligent design (29%).

Studies show that the vast majority of Americans have a strong appreciation for the role of science in health, education, and competitiveness, and they especially value the contribution that scientific research makes to eliminating diseases (4). Within this sample, 63% of respondents ranked developing medicines and curing diseases as the most important contributions of science to society. Proponents of teaching evolution (65%), creationism (62%), or intelligent design (63%) were equally likely to view these contributions as science's most important.

People also appear to value the relationship between evolutionary science and medicine. Among a sample of respondents, 61% thought that understanding the contribution that evolution makes to modern medical science, including to understanding and treating diseases such as avian influenza, was a convincing reason to teach evolution in science classes. This finding, together with Americans' consistently strong support of medical research (4), suggests that making the connection between evolutionary biology and advancing other areas of medical research (e.g., understanding human gene function or the mechanisms by which antibiotic resistance develops) might be equally compelling. People may also appreciate the contributions that evolutionary science makes to other fields, including agriculture, forensics, and even software engineering, although we did not examine these.

Teaching evolutionary science may also enhance science pedagogy, as it “offers educators a superb opportunity to illuminate the nature of science and to differentiate science from other forms of human endeavor and understanding” (6). The tools and techniques that scientists employ to study evolution—gathering evidence from various sources, making logical inferences, establishing and testing competing hypotheses—are the hallmarks of science and necessary for everyday decision-making. Data from this survey suggest that the public values these learning opportunities: a majority of respondents rated learning to draw conclusions from evidence (80%), to think critically (78%), and how science is conducted (63%) as very important purposes of public school science education. Communicating the value of learning science, including evolution, for developing analytical skills that are widely applicable beyond the classroom may strengthen public support for all types of science.

The scientific community—scientists, science teachers, and medical professionals—have a key role in communicating the importance of science education to the public. Sixty-nine percent of respondents had favorable feelings toward scientists and even more viewed medical researchers (72%) and doctors (76%) favorably. While fewer people (59%) rated public school science teachers highly, public school teachers in general were the most widely favored group (79%).



When it comes to scientific issues, the scientific community commands the attention of the public (Fig. 2). Among respondents presented with a list of people who might explain science to the public, 88% expressed interest in hearing from a scientist, and almost as many were interested in hearing from a science teacher (85%) or a doctor or nurse (84%). On the topics of evolution, creationism, and intelligent design, most respondents expressed interest in hearing from scientists (77%), science teachers (76%), and clergy (62%). Fewer

people were interested in hearing from Supreme Court Justices on evolution (37%), or from school board members and celebrities either on science (34% and 16%, respectively) and evolution (30% and 11%, respectively). These data indicate that Americans respect the expertise of science and education professionals and also look to clergy for guidance on scientific issues of potential relevance to religion. The value of encouraging each of these groups—including scientists who hold religious beliefs—to become involved in promoting quality science education cannot be overstated.

In communicating the value of science, scientists must emphasize the outcomes that matter to people—advancing medicine, improving health, fostering critical thinking—and they must do so clearly and understandably. Technical expositions on scientific topics will not get the attention of the public or policy makers who lack relevant expertise.

If researchers can not communicate their findings in ways that are comprehensible, meaningful, and relevant to non-scientists, their message to the public—and their effectiveness as spokespersons for science—is lost (7). There are ample opportunities for scientists to develop and exercise their communication skills and, whether writing letters to local newspapers, speaking with school boards or community groups, or partnering with educators to design curricula, many scientific and professional societies have trained staff or other resources to help.

There is a clear need for scientists to become involved in promoting science education. Challenges to teaching science undermine students' understanding of the scientific method, how scientific consensus develops, and the distinction between scientific and non-scientific explanations of natural phenomena. If our nation is to continue to develop the talent necessary to advance scientific and medical research, we must ensure that high standards in science education are maintained and that efforts to introduce non-science into science classes do not succeed. Failure to reach out effectively to a public that is supportive of science and open to information from the scientific community is not just a missed opportunity; it is a disservice to the scientific enterprise.

(Editor's Note: The reader is referred to the following link for further information: <http://evolution.faseb.org/sciencecoalition>)

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3. *Reading the Polls on Evolution and Creationism (The Pew Research Center for the People and the Press, Washington, DC, 2005; <http://peoplepress.org/commentary/display.php3?AnalysisID=118>).*
4. *America Speaks (Research!America, Alexandria, VA, 2007; <http://www.researchamerica.org/publications/AmericaSpeaks/AmericaSpeaksV8.pdf>).*
5. *Evolution, Creationism, Intelligent Design (The Gallup Poll; <http://www.galluppoll.com/content/default.aspx?ci=21814>).*
6. *National Academy of Sciences, Teaching About Evolution and the Nature of Science (National Academies Press, Washington, DC, 1998).*
7. M.C. Nisbet, C. Mooney, *Science* 316, 56 (2007).

Acknowledgments

The Coalition of Scientific Societies would like to thank the American Sociological Association for contributing to this research and Jennifer Berktold with Greenberg Quinlan Rosner Research for comments on an earlier draft of this manuscript.

Entrance-Into-Force of CTBT

David Hafemeister, Center for International Security and Cooperation, Stanford University

The Comprehensive Nuclear Test Ban Treaty (CTBT) bans all nuclear explosions of any yield in all places for all time. The United States signed the CTBT in 1996, but the US Senate denied advice and consent to CTBT ratification in 1999. Article XIV of CTBT requires a meeting about every two years until CTBT Enters Into Force, alternating between Vienna and the UN. The September 2007 Article XIV conference was attended by delegations from Iraq, Iran, Pakistan, China, Russia and 101 other nations, but the US, DPRK and India did not attend.¹ This paper gives the views of key member states on the purpose and direction of CTBT, an analysis of funding and regional acceptance, an analysis of advantages of CTBT over NPT, and a suggested path for entrance into force. Official proceedings were adjourned for a special two-hour session with Ambassador Jaap Ramaker (UN-CD Chief CTBT Negotiator) and three non-diplomats (Andreas Persbo, Daryl Kimball, and David Hafemeister).² The technical results on monitoring were published in *Science and Global Security*.³

Senate rejection of CTBT does not mean that the United States is free to test since it is bound as a CTBT signatory

by custom to the Vienna Convention on the Law of Treaties. For the US to resume testing, the Senate must vote to take the CTBT from the Executive Calendar, followed with a presidential statement that the CTBT is "jeopardizing its supreme interests." A two-step process was not needed when the US withdrew from the Antiballistic Missile Treaty since the ABMT resided in the Executive Branch.

A world without the Nuclear Non-Proliferation Treaty (NPT) would be much less stable since there would not be an international norm on nuclear proliferation. The five nuclear weapon states (NWS; China, France, Russia, US, UK) realized this danger when the NPT was going to expire in 1995. In order to extend the treaty for all time, the five weapon states agreed to a key condition by the 180 non-nuclear weapon states (NNWS), which required a promise to join the CTBT by the five NWSs, or else they would not extend the NPT for all time. Because of this, the NWSs all agreed to comply with a universal test ban. Three of the five weapon states (UK, France, Russia) have ratified the CTBT, while China awaits US ratification before it will ratify.

CTBT Indicators

The global nonproliferation regime is in under attack because of actions by other countries and because of US actions. The so-called axis of evil (Iraq, Iran, and North Korea were Clinton's "rogue states") cheated, but the successes of the NPT far surpass its losses. Thus far, only North Korea has built a couple of nuclear weapons (0.6 kton test on October 9, 2006), but many other nations that started nuclear weapon programs subsequently changed their minds (S. Africa, S. Korea, Taiwan, Libya, Brazil, Sweden, Belarus/Ukraine/Kazakhstan, and more). India, Israel, N. Korea and Pakistan are not NPT parties. Because NPT is a weakened treaty, CTBT is needed to add an additional barrier and to energize the global norm against proliferation.

NNWSs believe that CTBT is a pivotal litmus test to determine a nation's "walking-the-walk" consistency on nonproliferation matters. The UN General Assembly has passed four resolutions that "urges all nations to maintain their moratorium on nuclear-weapons test explosions...urges all nations that have not yet signed the Treaty to sign and ratify it as soon as possible...and urges all nations that had signed but not yet ratified...to accelerate their ratification process." The four UN General Assembly votes total to 694 in favor, 6 against (DPRK, Palau, 4 US votes) and 16 abstentions (4 votes each by Colombia, India, Mauritius, and Syria).

As of December 2007, 141 of the 177 signatories ratified CTBT. The main non-signatories are North Korea, Iraq, India, Saudi Arabia, Syria, and Pakistan. Since the last EIF meeting in 2005, 15 states ratified and 1 signed. Beyond ratification, dues payments and delegation strengths are two CTBT indicators that directly measure the intent to support the CTBT regime, and indirectly to support the NPT regime (Table 1). The total assessed budget for 2007 is \$110 million, with a funding deficit of \$22 million (November 2007, 20%). The total funding deficit over the years is \$50 million. CTBT Annex 2 contains a list of 44 states that must ratify CTBT for it to enter into force. Of the 10 states that have failed to ratify, three did not attend the EIF conference: India, North Korea and US. Three have not signed CTBT: North Korea, India and Pakistan. Four are fully paid: China, Egypt, Indonesia and Israel. Three have not fully paid their dues: Columbia, Iran, and US.

Delegation Statements at EIF-CTBT

Brazil (Amb. Antonio Guerreiro): "Brazil is deeply concerned with the fact that eleven years after the CTBT was opened for signature, the prohibition to conduct nuclear tests is not yet a legal obligation....Brazil there reaffirms its deep concerns

with the fact that some Nuclear Weapon States have been consistently trying to renege and back down on those commitments....In addition, it would allow States that have not ratified the Treaty, in particular those among them which are Nuclear-Weapon States, to enjoy nearly all of the benefits of the system without the need to abide by the legal obligations that provide the foundations of the CTBT regime....This situation is unacceptable and unsustainable, and if unchanged it will inexorably erode support to the CTBT and may ultimately lead to its demise."

China (Amb. Guoqiang Tang): "CTBT has served as pillar of the international system of arms control, disarmament and nonproliferation....The development of new type nuclear weapons and the accelerated development and deployment of the missile defense systems have brought negative effects on the global strategic balance and stability....The Chinese Government has by far submitted the Treaty to the National People's Congress for its review."

France (Amb. Francois Deniau): "nothing justifies that this simple and powerful gesture in favor of nuclear non-proliferation should be postponed until tomorrow."

Holy See (Rev. Msgr. Michael Banach): "The Holy See resolutely promotes the widest possible accession to the CTBT and its ratification....Sometimes States justify nuclear tests by appeal to the requirements of security and the protection of peoples. This argument fails to convince."

Israel (Amb. Itzhak Lederman): "Israel considers the prohibition of nuclear testing as pivotal to global nuclear non-proliferation regimes....Israel calls upon all states....[to] sustain the commitment not to carry out any nuclear weapon test explosion.... [and to] redouble the efforts to complete the verification regime."

Iran (Amb. Ali Soltanich): "In the 1995 NPT Review Conference, the Non-Nuclear Weapon States again showed their commitments and optimism toward this very important goal and agreed to the unlimited extension of the NPT, while still waiting for the positive response from the other side....[T]he rejection of the CTBT by the United States has damaged the prospect of the entry into force of the Treaty....[R]ejection of the On-Site Inspection and at the same time using advantages of receiving data from the International Monitoring System.... has raised grave concerns as well....The NWSs bear the main responsibility in entry into force of the CTBT and they should take the lead in this regard."

Japan (Senior Vice-Minister for Foreign Affairs): "The maintenance of the moratorium on nuclear testing is imperative. As the only nation ever to have suffered nuclear devastation, Japan calls on the international community to ensure that nuclear test-

Table 1. Delegate Numbers and Funding Deficits. This table includes the 5 nuclear weapon states (NWS), the 3 Axis Powers from World War II, and the *de facto* NWSs, where Iran is listed for convenience only. The first number in the parentheses is the number of delegates that attended the 2007 EIF conference and the second number is the total national funding deficit in millions of dollars.

NWS=WW2–Allies	Defacto NWS	Other
China (7, 0)	Signatories	Afghanistan (1, 0)
France (10, 0)	?Iran (3, 1.5M)	Argentina (2, 6.6M)
Russia (10, 0)	Israel (2, 0)	Brazil (4, 12M)
UK (7, 0)	Non-Signatories	Columbia (3, 1.3M)
US (0, 24M)	DPRK (0)	Egypt (4, 0)
	India (0)	Holy See (4, 0)
	Iraq (2)	Indonesia (5, 0)
WW2-Axis	Pakistan (2)	Libya (2, 0.2M)
Italy (7, 0)	Former D-NWS	Venezuela (6, 0.2M)
Japan (14, 0)	Belarus (4, 0)	UN (3)
Germany (5, 0)	Kazakhstan (6, 0)	IAEA (13)
	S Africa (3, 0)	OPCW (1)
	Ukraine (5, 0)	NGO speakers (4)

ing is never carried out by any country ever again.”

Pakistan (Amb. Shahbaz): “despite being a non-signatory State, we are not opposed to the objectives and purposes of the Treaty.... We were not the first to introduce nuclear weapons in South Asia and our nuclear tests in 1998 were meant to restore the strategic balance in the region.”

Russia (Amb. Alexander Zmeyerovskly): “We consider the CTBT as one of the key elements of the nuclear weapon non-proliferation regime and an important instrument for the maintenance of international security.” Russia would maintain its position of a voluntary nuclear testing moratorium “as long as other Nuclear Weapons States do the same.”

South Africa (Amb. L.M. Gumbi): “Recent pronouncements by some nuclear-weapon States... seem to suggest that the unspecific terms of Article VI of the NPT do not bind them to any specific timeframe to undertake their obligations under the Treaty.... The CTBT is not an instrument standing on its own, but forms part of a Treaty Regime that encompasses an interlinking network of obligations, commitments and undertakings that are focused on preventing the proliferation of nuclear weapons....”

United Nations (UN Secretary-General Ban Ki-moon, former Chairman of the CTBTO Preparatory Commission) “I see emerging in the world today, a ‘zero tolerance’ of any further tests of nuclear explosive devices. I hope to see the

day when this expectation is made legally binding and remain convinced that the CTBT is the way that this goal will ultimately be achieved.” (High Representative for Disarmament Affairs Sergio Duarte) “The key to accelerate the progress remains the leadership role of the United States would be ready to assume.”

CTBTO (Special Representative for Ratification Jaap Rammaker): “The world needs a complete ban on nuclear weapon test explosions.... This Treaty will cap the development of ever more destructive weapons. It constitutes the last barrier against a nuclear programme turning in a nuclear weapons programme.”

CTBT vs. NPT

Constraining the proliferation of nuclear weapons is complicated since it requires the cooperation of 50–100 larger nations. The US Office of Technology Assessment (1977) produced the first serious study on proliferation, with this key conclusion: “In the long run two general rules apply: (a) Solutions to the proliferation problem will have to be found primarily, though not exclusively, through multilateral actions, and (b) the extent of US influence will vary from country to country.” Since NPT Article IV does not block enrichment and reprocessing for peaceful purposes, it is necessary to have a further constraint on proliferation from a viable CTBT. CTBT is easier to enforce than the NPT for the following seven reasons:

1. CTBT has one class of nations. There is no distinction between NWS and NNWS. North equals South, and East equals West.
2. CTBT has no distinction between military and commercial uses.
3. CTBT is more narrowly defined. NPT Article IV allows enrichment, reprocessing, fuel fabrication, storage, reactor operation and more. CTBT bans only nuclear tests of all yields, while NPT constrains the entire fuel cycle. Brazil is allowed to enrich uranium, while Iran is not allowed to enrich. Because of the narrow definition of a nuclear test, sanctions against CTBT-violating states are more likely than against NPT violators.
4. CTBT can be better monitored. CTBT can be monitored to 0.1 kt (1–2 kt in a cavity, with difficulty).⁴ Cooperative monitoring at test sites can significantly lower this without the loss of secrets. NPT violations are not so clearly defined.
5. CTBT undetected violations are less serious. A successful violation by a NWS of 0.1 kt (1–2 kt in a cavity with difficulty) does not greatly affect the situation between NWSs. A successful violation by a NNWS is quite dif-

difficult to accomplish since NNWSs lack the experience of testing under 0.1 kt, and NNWS would have a difficult time preventing radionuclide venting, an issue that plagued the NWSs for decades. These small tests are less dangerous to the national security, and that threat exists without a CTBT. Violations of the NPT include the entire weapon and fuel cycles.

6. CTBT is less contentious. NPT five-year review conferences have had great difficulty obtaining consensus documents, which is not a problem with CTBT conferences.
7. CTBT has much more political support. The total of the four votes in the UN General Assembly (2003–2006) is 694 in favor, 6 opposed and 16 abstentions. Only the US, DPRK, and India failed to attend the 2007 CTBT-EIF conference. CTBT is needed to strengthen a weakened NPT, according to UN Secretary-General Ban Ki-moon, Chair of the Mass Destruction Commission Hans Blix, Former US Secretaries of State Henry Kissinger and George Schultz, Former US Defense Secretary William Perry, and Former Chair of the Senate Arms Services Committee Sam Nunn.

Path to Ratification in the US

The Senate ratification process in 1999 was deeply flawed. There were no questions for the record, and the Senate Foreign Relations Committee did not produce a CTBT Ratification Report for Senate floor debate. This is in contrast to SFRC's over 1000 questions for the record and 14 days of hearings after CTBT submission to the Senate. It is imperative that technical, legal and political questions be fully aired before the Senate re-considers CTBT ratification. In 2009, almost half the Senate (40–45 senators) will have been elected since the 1999 CTBT defeat. This process is manageable if the SFRC conducts a thorough review of CTBT. The CTBT Resolution of Ratification should address the concerns of Senators. General Shalikhshvili's CTBT report suggests a mechanism for this by recommending that the government

“should commit to conducting an intensive joint review of the Test Ban Treaty's net value for national security ten years after US ratification, and at ten-year intervals thereafter....If, after these steps, grave doubts remain about the Treaty's net value for US national security, the President, in consultation with Congress, would be prepared to withdraw from the Test Ban Treaty under the 'supreme national interests' clause.”⁵

Path to Global Entrance Into Force

There is no unique path towards obtaining the 10 necessary ratifications from the Annex 2 states to obtain CTBT Entrance into Force. It is generally assumed that the process begins with the United States. If the US ratifies, it is generally assumed that China will follow. With China and the US acting together, it is generally assumed that North Korea will ratify. Columbia generally supports CTBT, but is trying to avoid \$1.3 million in late payments; these modest funds can be obtained from other nations. Indonesia, a significant CTBT player will probably ratify. The next step would be the most difficult, as it necessitates a Middle-East Grand Bargain, which would obtain ratifications from Israel first and then Egypt and Iran. With China committed to a test ban, India could follow China. Pakistan has stated that it would ratify if India did.

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Endnotes

- ¹ http://www.ctbto.org/reference/article_xiv/2007/article_xiv07_main.htm
- ² <http://www.vertic.org/news.asp#ctbtreport>
- ³ D. Hafemeister, “Progress in CTBT Monitoring Since its 1999 Senate Defeat,” *Science and Global Security* 15(3), 151–183 (2007).
- ⁴ *National Academy of Sciences, Technical Issues Related to the Comprehensive Nuclear Test Ban Treaty (National Academy Press, Washington, DC, 2002).*
- ⁵ J.M. Shalikhshvili, *Findings and Recommendations Concerning the Comprehensive Nuclear Test Ban Treaty (US Department of State, January 2001), pg. 33.*

Editor's Comments, continued from page 1

could be used hundreds of times. The last time I saw Pief, a few months ago, I took a Stanford shuttle bus to his office. As he was showing me to the entrance door at the end of our meeting, I jokingly remarked, “Al Gore would be pleased to know about the minimal CO₂ emissions involved in getting me to SLAC today.” Without skipping a beat, Pief replied, “Just be sure to also minimize your methane emissions.”

COMMENTARY

This article is based on a 10 Nov 07 article in the Northwest Arkansas Times, where the author has a regular column that you can check out at <http://physics.uark.edu/hobson/>.

Winning the climate race

There's a disconnect between our business policies and physical reality. We're in a race with the reality of rising carbon dioxide (CO₂) levels, but our policies don't begin to reflect that fact.

From 12,000 years ago until 200 years ago, CO₂ levels remained near 280 parts per million (ppm). This period is a warm period in the ice age cycles. The period from 130,000 to 12,000 years ago was a typical ice age, with average temperatures 5 Celsius degrees colder than the past 12,000 years. There have been many such cold-to-warm ice age cycles. Scientists drilling ice cores two miles deep into Antarctic ice have deduced that, during the past 650,000 years, CO₂ levels were about 180 ppm during cold periods and 280 ppm during warm periods.

Beginning 200 years ago, CO₂ levels have gone through the roof. Today's level is 380 ppm, which is unprecedented not only in the past 650,000 years but probably in the past 20 million years. Driven mainly by fossil fuels, it's increasing by nearly 2 ppm every year. Because CO₂ traps the infrared energy that Earth radiates toward space, this is driving temperatures upward. Most people know by now that this is beginning to cause havoc, but our habits don't yet recognize that fact.

James Hansen, NASA's chief climate scientist, basing his reasoning on past ice core records, estimates that the climate system can tolerate a CO₂ level of no more than 450 ppm (and perhaps less) before passing a tipping point beyond which the Greenland and West Antarctic ice caps, driven by the same kinds of feedback mechanisms (primarily albedo feedback and greenhouse gas feedback) that drove temperature rises at the ends of past ice ages, will begin to irreversibly melt. This could raise sea levels by several meters by 2100 and by several meters per century for many centuries thereafter.¹ According to Hansen, if global warming reaches 2 or 3 degrees Celsius, as is predicted by the end of the century under business-as-usual, "we will likely see changes that make Earth a different planet than the one that existed for the past 10 millennia."²

Quite literally, saving the planet has become the central moral problem of our time. We are nearing that tipping point. The Arctic ocean is nearly half melted. Greenland, heated by a warmer Arctic ocean, is melting at its edges.

What would a viable global solution look like? To stay below

the 450 ppm tipping point, we must radically and quickly reduce global CO₂ emissions, by some 60 percent by about 2030. The only fair pathway toward this goal is one that converges toward equal per-capita emissions worldwide. Taking into account both the world population and the high current emissions in the industrialized world, this means that the rich countries must cut their emissions by some 90 percent by 2030.³

This is difficult but not impossible, as Britain's George Monbiot shows in his fine book *Heat: How to Stop the Planet from Burning*. He finds that the task is technologically doable and economically feasible—certainly more feasible than the failed economy resulting from continued warming. Here's how.

First, we must plug our leaky homes and businesses. For example, with tight insulation and south-facing glass, "passive" homes—having no heating or cooling systems—in Germany achieve average indoor temperatures of 70 degrees during the cold German winter. All new homes must meet similar standards.

Second, the utility industry must reduce emissions by promoting energy efficiency, switching to renewables, and burying the remaining CO₂. Efficiency is the "low-hanging fruit" of the energy business; for example, it's far cheaper to warm a house with insulation than with gas or electricity. Monbiot's careful study of energy from wind turbines, photovoltaics, "solar thermal" (sunlight focused onto a fluid that then generates power plant steam), and energy storage shows that half of utility-supplied energy could come from renewable sources. The remaining half could come from coal- or gas-burning plants whose CO₂ would be compressed and pumped safely and permanently underground.

Third, we must reform our pathological transportation system. Monbiot notes that transportation "should be easier to solve than the other problems.... Far from costing more money, a rational, efficient system, producing 10 percent of current emissions or less, would save us billions. But the real problem is neither technological nor economic. It is political or, more precisely, psychological."

Monbiot recommends a mix of transportation strategies. Eighty percent of car travel should be replaced by walking, bicycling, and buses. Driving should be discouraged by capping and rationing highway space, taxing automobiles and fuel, and removing our enormous driving subsidies. He condemns widespread use of biofuels because they consume too much agricultural land, argues that fuel cells won't be widespread for 25 years and are therefore irrelevant to reductions by 2030, and finds that hydrogen has severe drawbacks. The car of

the future is an ultra-efficient, lightweight, hybrid or plug-in hybrid. Up to 500 miles, air travel should be replaced by high speed trains that will get us there faster. Long air trips must be greatly curtailed.⁴

Social inertia will probably prevent the industrialized nations, and the United States in particular, from achieving a 90 percent reduction in emissions by 2030, although there is some realistic hope that we might achieve it by 2050. Thus, the planet is likely to be skating on very thin ice after about 2030.

References

1. James Hansen with 5 co-authors, "Climate change and trace gases," *Philosophical Transactions of the Royal Society A*, Vol. 365, pp. 1925-1954 (18 May 2007).
2. James Hansen with 46 co-authors, "Dangerous human-made interference with climate: a GISS modelE study," *Atmospheric Chemistry and Physics*, Vol 7, pp. 2287-2312 (2007).
3. George Monbiot, *Heat: How to stop the Planet from Burning* (South End Press, Cambridge MA, 2007), p. 16.
4. *Concerning travel to APS and other meetings*, see Benjamin Lester, "Greening the meeting," *Science*, 5 Oct 2007, pp. 36-38.

LETTERS

To the editor:

While authors might not like to see their creations panned, reviewers have every right to find fault with them—and our book, *Nuclear Shadowboxing*, [1] is no exception. But reviewers do have obligations. While entitled to point out perceived logical and substantive flaws, and also our (readily admitted) failures to communicate effectively, the *Physics & Society* reviewer [2] should have made his objections clear. He didn't. He failed to appraise coherently the content and significance of both Volumes 1 and 2, especially the latter. Our response here is not so much to defend the book as to fill a void by clarifying why it contributes to "the interface of physics and society," in the spirit of *Physics & Society's* charter.

We are now-retired nuclear physicists and engineers from both sides of the former Iron Curtain, with a unique combination of hands-on knowledge and skills in just about every aspect of nuclear weapons and arms control. We collaborated to provide, for the benefit of future evaluators of policy, a 1000-page (900,000-word) history and analysis of Cold War weaponry and lessons to be learned—topics often viewed as complex, obtuse, controversial, and easily misunderstood.

The reviewer is perceptive in calling the two volumes "a labor of love." We could not find a publisher for this comprehensive and specialized tome, so we had to self-publish at our own expense; we have barely recouped our printing costs. Without remuneration, the four of us devoted more than twelve intense, parttime years to putting on paper the essentials of our unparalleled collective professional and personal experience during the Cold War.

Moreover, we do *not* "reiterate the existing consensus of academic physical scientists." Our experience goes well beyond the classroom. Between us we have first-hand knowledge of much of our subject matter, often acquired in the field—sometimes under dicey situations. While many historians and academics do a great job of canvassing, distilling, and

interpreting historical events, we submit that *Nuclear Shadowboxing* adds a unique perspective.

Ironically, the reviewer disapproves of our efforts to divide complex content into readily accessible subtopics. Why would a detailed table of contents be a topic for derision? We thought that making the book more searchable and readable was worth considerable effort because of the complex and interconnected subject matter. It's hard to see why "accurate tables of contents make unclear substance dimmer still."

Some of the reviewer's criticisms are out of context. Statements he interprets as "prescriptions" are usually not ours; instead they are distillations from cited sources, included for historical context. Obviously we have our opinions—which we see as driven by the facts—and we hope it does not take much reading between the lines to tell when an opinion is ours and when it is someone else's.

While we deserve criticism for some organizational deficiencies, the reviewer does not bring up any specific factual errors. Meanwhile, he himself has made errors of fact, scholarship, and interpretation. For example, in the review of Volume 1 he misspells the lead author's name as "Alex L. Volpi"; in this world of metasearches, the result is added confusion. He alleges, incorrectly, that at one point in Volume 2 we inconsistently list weapons-grade plutonium "as 20% fissile"; that is not done, on the pages cited or anywhere else, and it runs counter to an overbearing sub-theme throughout the book. And he frequently misattributes to us material quoted from others.

The reviewer thinks that "Some of the book's [Volume 1] statements are plainly stupid (or racist?)"—but the example cited is from a thoughtful assessment of Russian culture by a native Russian (Minkov) whose analysis, we insist, is incisive, not stupid.

The review inconsistently oscillates objections about too-much/too-little supporting substance, too-much/toolittle

thematic structuring, and too-much/too-little “involved” [complex?] subject matter. And then it implies that we should add more details, such as the name of the German youth (Matias Rust) who landed a small plane in Red Square in 1987. Moreover, does the passing reference to Quemoy and Matsuo need explanation? We could, indeed, have put in a footnote; however, nowadays one can easily do a Google search to brush up on that sort of historical detail.

We are particularly concerned that a potential reader might be misdirected by excerpts in the critique that are seriously out of context, such as the reviewer’s remarks about de-MIRVing and countermeasures. Nevertheless, we have reason to be thankful to the editors of *Physics & Society* and to the reviewer. We are pleased that he “would recommend [Volume 1] to history teachers in order to present a more balanced picture of the Cold War . . .” Also, he encourages us to draw from *Nuclear Shadowboxing* a “new [more personal] book” (which, in fact, is nearly ready, titled *Nuclear Insights*. Now, if somebody could find us a publisher . . .). Meanwhile, we are preparing a revised edition of both *Nuclear Shadowboxing* volumes with changes, updates and, indeed, corrections.

Both the reviewer and the Forum on Physics and Society are making a responsible contribution by affording space to a topic that has a very limited commercial market, yet is fundamental to understanding the consequences and implications of the interplay between nuclear technology and the nearly catastrophic Cold War.

As a final note, we quote with appreciation the reviewer’s closing comment about Volume 1: Even in its current, imperfect and awkward form — and what else would one expect from a first undertaking of this magnitude completed without public financing — *Nuclear Shadowboxing* deserves to be on the shelves of every public and school library in the United States.

—Alexander DeVolpi, Vladimir E. Minkov, and George S. Stanford

Endnotes

1. Alexander DeVolpi, Vladimir E. Minkov, Vadim E. Simonenko and George S. Stanford, *Nuclear Shadowboxing: Contemporary Threats from Cold War Weaponry (Volume 1: Cold War Redux, 2004; Volume 2: Legacies and Challenges, 2005)* (www.NuclearShadowboxing.INFO).
2. Peter B. Lerner, *Physics & Society, Reviews (Volume 1 reviewed July 2006 and Volume 2 reviewed July 2007)*.

Peter B. Lerner’s response

One of the French greats, Balzac or Stendhal, suggested that the author’s professed opinion about his own book must be given as much consideration as the courtesan’s opinion about her current lover. Having a vague idea of the private lives of the two French greats, I doubt that either of them could find

this statement derogatory to the authors, courtesans, or their lovers for that matter.

Equally, I do not see anything diminutive in my characterization of the general outlook of the authors on nuclear disarmament as “reiterating the existing consensus of academic physical scientists.” This group includes, among others, H. Bethe, R. Garwin, S. Drell, and W. Panofsky, all of whom had first-hand knowledge of nuclear weapons research. This characterization was evoked only to emphasize that even the views of well-meaning and competent Americans concerning military applications of nuclear technology can be very remote from the rest of the world.

As far as the number and choice of topics is concerned, I stand by my opinion that the treatment is chaotic and confusing. Careful selection of material and organization of ideas is a high art. For instance, writers of encyclopedia entries have typical limitations of 500-1000 words and 4-6 main references, in which they must squeeze sometimes very complex and specialized subjects (e.g. “Philosophy, Greek, Hellenistic period.”). There are different strategies to cope with the challenge of a burgeoning subject, e.g., mathematicians frequently choose one central idea or method, ignoring competing approaches, etc. etc. But no coping strategies seem to have worked for the authors. Also, contradictions such as the appearance of two numbers for the same quantity on adjacent pages does not contribute to better understanding.

Finally, I am glad that my assessment of the statement: “The economic well-being of the Russian population is considered secondary. President Putin understands well that [Great Power] status cannot be returned through great economic achievements; there is no widespread entrepreneurial spirit of the Western type in Russian culture (p. xii, Vol. 1)” as stupid and racist passed under the editor’s radar screen. The fact that such statements abound in the current (especially British) press does not make them more accurate or less repugnant. It is also laughable in view of how much effort is made by the EU to prohibit the sale of European companies to the Russians. Certainly, 30+ Russian billionaires would laugh all the way to the bank at their lack of “entrepreneurial spirit.”

If the four authors found my modestly critical comments of their book offensive, they must have been very lucky with the anonymous referees of their technical papers. In these litigious times even the screenwriting agents are afraid to speak their minds. Criticisms restricted to platitudes such as “. . .we feel that your work provides an insufficient match to the demands of our clients,” such reviews leave the readers and anybody else with nothing to learn. Finally, if the controversy is the mother of sales, the authors of “Nuclear Shadowboxing” must thank me for increasing their sales, which they grudgingly do.

REVIEWS

Five Days in August: How World War II Became a Nuclear War.

Michael D. Gordin (Princeton: Princeton UP, 2007) ISBN 978-0-691-12818-4, xv + 209 pp, \$24.95.

Every August, media sources briefly remind us of the atomic bombings of Hiroshima and Nagasaki and the subsequent end of World War II, sound bites that feed the perception that atomic weapons ended the war. Almost as frequently it seems, historians feel compelled to identify (create?) and mine new niches and interpretations of this period of history. Indeed, the cover blurb of this work promises that it casts various legacies of the atomic bomb in a “glaring new light.”

Michael Gordin’s central theses are that the popular notions that atomic bombs were responsible for ending the war and that it was known that two such bombs would suffice are erroneous, and posits that the notion of atomic bombs as “special” was a consensus that was constructed after they were used. Part of his argument is that at the time of their use many military, scientific, and political figures were not at all convinced that nuclear weapons would work and, even if they did, considered them no more than equivalent to conventional weapons, hardly likely to bring a sudden close to the war.

This book is a quick read: Of its 209 pages of text nearly 50 pages are endnotes. The text comprises seven chapters. Curiously, I apparently missed any explanation of what five days Gordin has in mind in the title; my guess is August 6-10, the period from the Hiroshima bombing to when the Japanese considered conditional surrender. Chapter 1 serves as an introduction, setting out Gordin’s desire to frame his narrative as a military history. The remaining chapters are organized in pairs, and respectively deal with the timing of why the bombs were used when they were, the place from which they were deployed, and then an “apotheosis” of how “this unusual-yet-ordinary weapon” was turned into an extraordinary one in the postwar world.

Chapter 2 sets the context of the spring of 1945, reviews statistics of bombing missions, describes internal politicking in the US State Department, and emphasizes how the coincidence of the timing of atomic bomb development and the Potsdam Declaration rendered it a perfect shock strategy. Chapter 3 examines the issue of target selection and corresponding military orders. Much emphasis appears in this chapter on what Gordin terms the “two-bomb myth”—that the US knew in advance that two bombs would be sufficient to induce surrender. Over years of extensive reading on the

history of the Manhattan Project, I do not recall ever seeing an explicit reference to the notion that two bombs would suffice; indeed, it is well-known that Hanford and Oak Ridge were capable of producing bombs on an extensive scale. This chapter also includes a brief discussion of some of the relevant scientific history and concepts, but this is marred by a number of errors: it is stated that reactors require enriched uranium to produce plutonium; we are told that Fat Man was named after Sidney Greenstreet’s character in *The Maltese Falcon*, and Gordin asserts that radiation safety was a very marginal aspect of the Manhattan Project.

Chapter 4 describes the history of Tinian island, its seizure by the Marines in July 1944, the development and training of the 509th Composite Group, Project Alberta, and the Hiroshima strike. Chapter 5 describes post-Hiroshima reaction in the US, preparations made for more atomic drops, and how invasion plans were modified to utilize atomic bombs. All of this is to argue that atomic bombs were becoming “normalized.” Gordin emphasizes this, but in the chaos of surrender negotiations set against the possibility of a coup in Japan the only prudent course would have been to maintain air attacks and keep revising the enormously intricate invasion preparations until the situation clarified. This chapter opens with a deconstruction of President Truman’s announcement of the Hiroshima bombing, criticizing it for “conventionalizing” the atomic bomb by comparing it to a conventional bomb. But what else would one do in such circumstances?

Chapter 6 chronicles how the uncertainty that made a third atomic bombing a probability was “effaced from memory” and how the bomb became elevated to a special, unique status. Chapter 7 traces the legacies of Cold War atomic warfare strategies. An interesting point made in this chapter is how quickly public fears of nuclear annihilation, and war planning based on extensive use of atomic bombs, took hold, far out of any realistic proportion to the actual number of weapons available. Gordin closes with a reassertion of his fundamental thesis that war planners, journalists, and scientists worked hard to make atomic bombs into extraordinary “shocks” in the hopes of persuading the Japanese government to unconditionally surrender and that this shock interpretation subsequently became naturalized as a result of standard-procedure decisions and public-relations campaigns.

In the end, I was left asking “What is new here?” Indeed, Gordin often refers readers to existing literature for more extensive treatments of various topics. That the war continued for nearly a week after Nagasaki, that the Russian declara-

tion of war was perhaps even more shocking to the Japanese government than the atomic bombs, and that General Groves built the Manhattan Project to produce weapons on a vast scale will all be well-known to readers familiar with this history. The misconception that “the bombs ended the war” seems a flimsy edifice on which to attempt to build a new interpretation of the dawn of the nuclear age.

Finally, a disturbing aspect of this book is the cover art, a photograph of a Bell VB-13 “Tarzon” bomb. Development of this radio-guided bomb began in February 1945 and it saw some use in Korea but it had nothing to do with the Manhattan Project and was apparently never configured as a nuclear weapon.

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Darwin’s Nemesis: Phillip Johnson and the Intelligent Design Movement

William A. Dembski, ed., *InterVarsity Press, Downers Grove, IL, 2006. ISBN 0-8308-2863-2*

A longer version of this review appeared in Reports of the National Center for Science Education 26(6), Nov-Dec 2006, pp. 30-33. <<http://www.natcensci.ed.org>>

In April 2004, the leading lights of “intelligent design” creationism (IDC) met at Biola University (formerly the Bible Institute of Los Angeles) to confer on their “godfather,” law professor Phillip Johnson, the Phillip E. Johnson Award for Liberty and Truth. Thus began a two-day conference entitled “Intelligent Design and the Future of Science.” The talks formed the basis for the present volume.

This book gives a pretty good picture of what IDC really means to its advocates. The subject matter of the papers ranges widely; I’ll try below to give the flavor of some of them. But first let’s survey the contradictory faces that IDC presents to the general public (it’s science!) and to its friends (our mission is to impose our God on every aspect of society).

In his preface, William Dembski writes of a 1992 meeting, “Here, for the first time, a radical non-materialist critique of Darwinism and naturalistic evolutionary theories was put on the table for a high-level, reasoned, academic discussion without anyone promoting a religious or sectarian agenda” (p. 14, emphasis added). But given that Darwin’s Nemesis is an insider work, that’s about all there is of the public face. Almost all of the rest of the book consists of one argument after another supporting the superiority of a theistic—and

almost always a specifically “Christian”—worldview, with science reduced to the medieval role of handmaiden of theology. Examples:

Christianity is not burdened with the requirement that everything result from natural processes. ...Either natural or supernatural explanations of nature are allowed. In the study of biology, ...Christians have a broader palette of explanations to draw on than do materialists. (Timothy G. Standish, p. 119)

Years before, as a seminary student at Unification Theological Seminary in the late 1970s, I had become convinced that there is a fundamental conflict between theistic religions and Darwinian evolution. ...Now I realized I couldn’t be a theist and a Darwinian. (Jonathan Wells, pp. 164–5)

If Darwinism is true, Christian metaphysics is a fantasy. (Nancy Pearcey, quoting a 2002 interview of Phillip Johnson, p. 228)

Complexity theory views the essence of life as independent of its particular physical medium, consistent with Christian belief. ...We are thankful that the God of Christ’s love is also the God of purpose and order who superintends complexity and chaos. (Wesley D. Allen and Henry F. Schaeffer III, p. 300)

If there were still reason to doubt that IDC is about religion, not science, a scrutiny of the speakers at this “scientific” conference yields further revelations. Using the biographical information at the back of the book itself, together with a quick internet search, I tallied the disciplines in which the twenty-one participants had degrees. Here is how the disciplines stack up: 19 degrees in theology, religion, or philosophy; 9 in the physical sciences or engineering; 4 in the social sciences; 3 in biology, microbiology, or biochemistry; 3 in geology and earth sciences; 2 in law; 2 in mathematics; 1 in environmental biology and public policy. This is not quite the lineup one might find at a conference on evolutionary biology, but not surprising for an evangelical revival meeting.

Let me now turn to some of the more interesting chapters. Michael Behe, the father of “irreducible complexity” and of nine children (whose names he enumerates in his essay), is a lot of fun. He presents a folksy account of his Catholic childhood in an enormous family, his early uncritical acceptance of evolution as he had been taught it in Catholic schools, and the doubts gradually instilled, first by an evangelical lab technician he dated, and later by a series of other events. In particular, he infers on the basis of a conversation with a fellow Catholic postdoc that deep down, biologists don’t really think that life could have originated through natural means. All this is cemented by his early contacts with law professor Johnson, who instructs him in the underlying realities of the biological sciences.

Thomas Woodward devotes most of his essay to a contrast between Johnson's rhetoric and that of mainline evolutionary scientists. I am not sure what essential contribution rhetoric can make in forwarding the sciences, but Woodward's most interesting point is this: "... I was amazed once to hear a brilliant rhetorician ...describe the issue of God's existence as a nonrhetorical issue, implying that it is a purely subjective (that is, non-rational) issue, one that cannot really be argued at all." In a long footnote, he expands on his objections to this position. They boil down to a dilemma: We can be sure that his intercourse with a very personal God is extensive; otherwise he could hardly continue as a professor of Bible and Theology at the small bible college where he teaches. But he wants objective, external evidence of God that will have more weight with others. If only science would pursue evidence of the supernatural, as Johnson insists it should! In this light, Woodward's support of IDC is entirely understandable. Receiving the Holy Spirit oneself is the sine qua non for evangelicals; disseminating it to others is the Great Commission. Even as a non-scientist, he could hope one day to see a newspaper headline something like, "Scientist Finds DNA Sequence That Decodes As 'I Am Who Am.'"

But to get to the heart of the matter, is IDC really science? If it were, IDC-based papers would be making floods of new, groundbreaking contributions to the sciences and would be vigorously debated in scientific journals. The one paper that actually made it into a journal is reprinted here. Stephen C. Meyer's paper "The Origin of Biological Information and the Higher Taxonomic Categories" was published in the *Proceedings of the Biological Society of Washington* 117(2), 2004, pp. 213-39. As Meyer's brief biography notes (p. 352), it "created an international sensation." It turned out that the editor of the journal, who had no expertise on the subject matter, had creationist leanings of his own. He therefore published the paper, though it had nothing to do with the specialized field of the journal. The result was indeed a sensation – or rather a scandal. The upshot was that the Biological Society of Washington officially deemed the paper "inappropriate." For an analysis, see <http://www.pandasthumb.org/archives/2004/08/meyers_hopeless_1.html>.

The last section of Darwin's *Nemesis* moves beyond scientific issues into the realm that really concerns most creationists, namely, what they see as the baleful influence of evolution in the areas of theology, philosophy, and the extrascientific world in general. Nancy Pearcey expounds on the connections between "Darwinism" and abortion, sexual promiscuity, and postmodernism. She concludes, "The Darwinian creation story leads to an upper story of postmodern relativism, and ultimately undercuts itself. But Christianity offers a rationally coherent, logically consistent worldview..."

It lays claim to be truth about every aspect of reality... In that sense it is total Truth" (p. 243, emphasis in original).

The chapter "Complexity, Chaos, and God" is the most intelligent and interesting part of the whole book. In it, chemists Wesley D. Allen and Henry F. Schaeffer III use a clear if brief exposition of the essence of chaos theory—extreme sensitivity to initial conditions—to explicate the ancient theological dilemma of human free will versus the determinism implied by divine omnipotence/omniscience. Many real-world systems are chaotic in this sense. Hence, for humans the course of the universe is unpredictable and free will operates; for God, who can perfectly control the initial conditions, the universe is deterministic.

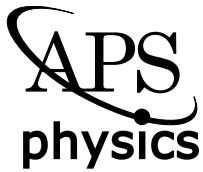
A pretty application of physics to theology; so far, so good. But Allen and Schaeffer lose me, I fear, when they make parallels between chaos theory and the Christian's ultimate fate as revealed in 1 and 2 Corinthians, from which they infer that "[t]he concept of a human soul can be retained in complexity theory as an emergent, nonreducible collection of properties or essences."

Astoundingly, they then take Dembski's "fourth law of thermodynamics" seriously. As physical chemists, they should know better; the mathematics and physics of Dembski's arguments have been thoroughly and definitively demolished by numerous experts [see Mark Perakh's *Unintelligent Design* (Prometheus Books, Amherst, NY, 2004, ch. 1), or his "A Free Lunch in a Mousetrap", <http://www.talkreason.org/articles/dem_nfl.cfm>].

The decision in *Kitzmiller v Dover* came down as editor Dembski was preparing the preface. He tries to make the best of Judge Jones's devastating critique of IDC, which bears heavily on its essentially and ineluctably religious nature—a point that this book can only reinforce. But Dembski is absolutely correct when he writes, "Ultimately, the significance of a court case like *Kitzmiller v Dover* depends not on a judge's decision but on the cultural forces that serve as the backdrop against which the decision is made." It remains to be seen how American society will react in the broader sense—onward and upward with science or into a new Dark Age with concern for the soul's fate in the afterlife trumping interaction with the material world in which we pass our lives.

For those who want to take the trouble (and it is a good deal of trouble) to delve into the inner motivations of "intelligent design" creationists, Darwin's *Nemesis* is a good source. Needless to say, I do not recommend it to the casual reader!

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