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Editors Comments

Almost everybody in this country seems to like "scientific research" - it appears to promise improved health, wealth, and security for the nation. But, as indicated by the News item about the continued decline in numbers of American physics Ph.D.'s, fewer and fewer of the usual-male-American students seem willing to commit themselves to the dedicated, prolonged, stressful research apprenticeship implicit in a Ph.D. program. Fortunately, the laboratories and libraries of our research universities are being kept from closing down by foreign students and increasing numbers of woman students. It is still too early to tell whether the reported recent increase in undergraduate physics majors foretells an increase in the quantity and quality of our graduate programs or a much needed improvement in the level of high school science teaching. Certainly, the current national budget commitment

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to science research and education (e.g., a proposed NSF budget "34% below where it should be", cf., Editor's Comment, P&S, April 2005), and the state budgets with which I am familiar, will not support any major improvements in the near future.

Perhaps more troubling is the confusion, in the public and political mind, as to what this vaunted "scientific research" is. As the news item on the shifting goals of the international space station indicates, the U.S. space station program has shifted from that of a very expensive - though possibly very productive - research laboratory to a very expensive mere "bus stop" - a way station on a route to the Moon and Mars. Or has it shifted into a taxpayer funded means "for private-sector commercialization of products?" In contemplating this shift, we must sadly realize that - in spite of the large-scale exposure of college students to science as taught by scientists - the "science" of scientists (an international "evidence based" community) is not the science of the American politician, business person, or taxpayer.

Nor, apparently, is it the science of the military. The high level technology upon which America relies for its military security depends upon science for its design, creation, testing, and validation. In a world of finite resources, it is not a wise priority to procure and rely upon tools whose proper functioning, in the realm of their anticipated use, has not been validated. Proper calibration and validation of tools is an integral part of science, even if the usual science process is open to inspection and duplication by others. All the more so is such validation necessary when the process is not open to others and may be the grounds upon which national survival rests. Yet, as the Boston Globe editorial in the news section suggests, not only is the validity of the testing of the-very expensive - American missile defense program doubtful, but also the scientific integrity of one of America's premier academic institutions. If scientific fraud has been countenanced by MIT, how can we expect American science - and its concomitant health, wealth, and security - to flourish?

Underlying the confusion shown by the American public as to the nature of science is the evident failure of our college science teaching to communicate the nature of science to the bulk of our students. As I noted, in the January issue, many of our students finish their undergraduate careers possessed of a split brain-at least with respect to science. They can pass enough of the required science courses to get their degree, but refuse to make the - supposedly learned - science a foundation for their out-of-school lives. In his Commentary, David Griffith suggests that the two-brain syndrome may be alleviated by better science teaching: teach fewer topics but emphasize their historical and cultural development. But many of us try to do exactly that in our teaching. I certainly made a major effort in that direction in the introductory astronomy course which I've taught for the past few years. The result was my recognition of the "two-brain syndrome", a recognition spurred by the intelligent honesty of one of my students. She raised the question: in which age of the earth should she believe - the several thousand years of the Biblical literalists, in whose fold she had been raised, or the several billion years of the university science departments, in which she was just a short term visitor? Given the rising controversy in the land about the relation between science and religion, as manifested in contentions about "brain death", evolution, cosmology (e.g., see the AAPT statement in the News section and the NY Times "op-ed" in the Commentary), this question can not be merely dismissed as backwoods musings. We face the possibility of a contentious "two-society" country, one based upon "rationality", the other upon "faith". I believe that our scientist-readers must strive for some insight into the thinking of an honest contemporary "faith based" non-scientist. In further, post-school, conversation with her, I raised a question:

> Emily: thank you for a very pleasant lunch last Friday. there is one question which I neglected to raise and which is very important to my understanding of our differences. It is:
>
> If the truths of the Bible are eternal (as I expect you to believe), then why is it so important, to you and your fellow believers, how old the Earth actually is: 6 thousand years or 4 billion years? Why is it so necessary for you to throw out the results of 2 thousand years of scientific endeavor making use of humanities rational facilities, one of God's great gifts to us?

Her response is her Commentary on "faith". I don't believe she has really addressed my question; perhaps it is too uncomfortable. She raises the counter question: does faith in God take priority over man's rationality? But the question of priority implies a conflict; is this conflict really necessary? She asks about rationality replacing the need for God. But I know of nothing in main-line science that requires the replacement of God by human rationality. The contention will continue. Hopefully, further discussion will make the questions more pointed, failure to address them more difficult - for all parties. Really dealing, honestly and completely, with the questions may dampen down the contentions in our society, help restore some broader sense of civility. Or will it?

Though the previous items may lead to some doubts and qualms about the future of our science, we can certainly look back with pride. As our two articles show, physics has inculcated its past

practitioners and leaders with very humane values. As physics is an active struggle with the physical world, so have physicists been active in struggling to preserve and extend human rights, liberties, security, and dignity. We've always known that Einstein was a stalwart in such matters but the article on APS endeavors in the field shows that Einstein was not a distant outlyer.

And so we have to hope and strive to overcome the dichotomies of the two-brain individual and the two-society America.

A.M.S.

ARTICLES

The American Physical Society's Involvement in the Defense of Human Rights

Edward Gerjuoy

(Adapted from paper given at FPS Session, APS Meeting March 2005)

The objective of this paper is to describe the history of our Society's past involvement in the defense of human rights.

Here is what the APS Bylaws say about CIFS:

"The membership of the Committee on International Freedom of Scientists shall consist of nine members appointed by the President-Elect to staggered three-year terms. The President-Elect shall appoint the Chairperson from among the members. The Committee shall be responsible for monitoring concerns regarding the human rights of scientists throughout the world. It shall apprise the President, the Executive Board and Council of problems encountered by scientists in the pursuit of their scientific interests or in effecting satisfactory communication with other scientists and may recommend to the President, the Executive Board and Council appropriate courses of action designed to alleviate such problems."

Note that the Bylaws do not restrict CIFS actions to matters affecting the APS and its physicist members, or even to matters affecting physicists worldwide whether APS members or not. Instead CIFS is affirmatively charged to monitor concerns regarding the human rights of scientists, not merely physicists, throughout the world. Moreover the APS has been willing to put its money where its mouth is. The financial contributions by APS to its human rights activities, expended on items such as staff time, travel, etc., amount to about $65,000 to $70,000 per year, above and beyond the valuation one might put on the time of the APS members who voluntarily serve on CIFS.

A primary objective of this paper is to acquaint this audience with some of the many actions CIFS has undertaken in its attempts to alleviate the human rights violations scientists worldwide have suffered. Until 1976 the APS had no formal mechanisms for engaging in human rights activities. Indeed until 1974 the APS had no formal mechanisms for any public affairs involvements, which is not to say that before 1974 the APS had been indifferent to public affairs.

In 1974, however, the Society created a Bylaws Committee called the Panel on Public Affairs (POPA), whose charge was to advise the APS Council on public affairs issues. POPA soon came to the conclusion that public affairs issues of APS concern had to include human rights violations the world over. POPA therefore set up a subcommittee to advise POPA, and ultimately the APS, on matters falling under the rubric of international human rights violations. By early 1976 this subcommittee had begun to function, and had been named the Committee on International Freedom of Scientists.

The CIFS' first report, dated April 1976 said:

"The Committee was formed to deal with those matters of an international nature that endanger the abilities of scientists to function as scientists. The Committee is to be particularly concerned with acts of governments or organizations, which through violation of generally recognized human rights, restrict or destroy the ability of scientists to function as such. The particular motivation for formation of the committee was the situation of the Soviet Refusniks; however, the province of the Committee is to cover all international matters infringing freedom of scientists as such. The title of the Committee has been chosen, with this in mind, after much discussion."

Except for its explicit reference to the refusniks, Soviet Jews who had lost their jobs and related privileges after requesting permission to emigrate to Israel, this first report of CIFS does not greatly differ from the CIFS' charge prescribed in the present APS Bylaws. The APS luminaries who were consulted on the wording of CIFS' province and who chose CIFS' name only "after much discussion," included: William Fowler, Phil Morse, Herman Feshbach, John Wheeler, and Ernest Henley. Fowler was the APS President at the time, and every one of the other physicists just listed also served as APS President at some other time.

In 1980, only four years after CIFS had begun its work, the APS Council split CIFS from its parent APS committee POPA and established CIFS as an independent Bylaws committee with essentially the same charge it has today. In the interim the APS Council had become so convinced of the importance of its human rights activities that in May 1978 it published, in the Bulletin of the APS, a "Statement of Principles for the American Physical Society Activities With Regard to Human Rights," whose opening paragraph stated:

"[The APS activities in the area of human rights of scientists] reflect the APS's conviction that science and scientific activity are important for the dignity of man and the future of civilization, and that interference with science anywhere is potentially harmful to all mankind and to society everywhere."

Those APS activities can be listed under at least six different subheadings. Only two of these activity subheadings (not necessarily the most important) will be discussed in any detail, namely the small committee program and letter writing, though brief mention will be made of all six..

CIFS' first Chair, during the years 1976-78 when CIFS still was a subcommittee of POPA, was Bernard Cooper. Under Cooper, CIFS initiated its program of forming so-called "small committees" for persecuted scientists, following a practice developed (I believe) by Amnesty International. Each small committee, consisting usually of three persons, "adopts" a single persecuted scientist and agrees to write said scientist and his/her family on a regular basis, whether or not there is evidence the letters are being received. The idea is that these letters, if received by the intended recipient and family, surely will fulfill the useful function of heartening them. But, and

this is the major point, even if the letters are being intercepted by the persecuting nation's secret police and/or prison officials, the letters are demonstrating that the victimized scientist has not been forgotten by the outside world, thereby hopefully easing the scientist's treatment or at least deterring extreme persecutions like torture.

I judge that of the many APS human rights activities, its small committee program has been one of the least publicized, to APS members as well as to the general public, which is the main reason I have chosen to devote a major portion of this paper to this APS activity. The program began with only a few committees, but the number of committees grew rapidly, so that it soon proved necessary for the program to have a "coordinator". For example, in 1983 there already were 97 small committee members, coordinated by Julian Heicklen of the Penn State University Dept. of Chemistry, writing to 63 oppressed scientists. By 1985 these numbers had increased, to 84 small committees with a total membership of 167. Most of the small committee members were physicists, and just about all of them were scientists. Many of the small committee members had accepted the responsibility of writing to more than one victimized scientist. The APS, the world, owes a long overdue expression of gratitude to every one of those small committee members who essentially anonymously, without fanfare, regularly wrote so many letters of encouragement to so many human rights victims, often with little expectation that the letters would reach their intended recipients. Heartfelt thanks also are owed to the various small committee coordinators, especially to Julian Heicklen, to Edward Stern of the University of Washington, and to Bernard Feldman of the University of Missouri, each of whom was willing to undertake the important task of coordinating the small committees even though coordination required an inordinate expenditure of time.

The number of small committees reached its maximum of 102 in 1986, but decreased fairly steadily thereafter. By 2000 the number had fallen to 10, still being coordinated by Feldman. In 2001 CIFS voted to terminate its small committee program, therewith pretty much ending organized letter writing by APS members to human rights victims. Why the yearly numbers of small committees rose and fell as they did merits some comments, which I will offer in a moment. I first want to say, however, that even if the small committee format has outlived its usefulness, I greatly regret that the APS has not retained some mechanism whereby regular communications to selected human rights victims and their families, serving the morale raising and related functions I have described, can be efficiently initiated.

Of the 84 scientists being supported by small committees in 1985, all but two were in the Soviet Union; the two non-Soviet scientists were Polish. This small committee singling out of Soviet scientists is easy to understand. By the 1970s the United States physics community had become well acquainted, personally as well as professionally, with the Soviet physics community; certainly in those years the American physics community was far better acquainted with the Soviet physics community than with any other physics community living under a repressive regime, e.g., the Chinese physics community. Thus the ruthless Soviet persecution of large numbers of scientists in the 1970s and 1980s, merely for peacefully criticizing their government or for seeking to emigrate, drew the attention of many American physicists and even earned recognition in CIFS' original 1976 province, which (as you will recall) said that "the particular motivation" for the formation of CIFS was "the situation of the Soviet Refusniks".

Soviet physicists for whom small committees were formed during the 1970s and 1980s include well known names like Andrei Sakharov, Yuri Orlov and Natan Shcharansky, as well as at least 100 lesser known names such as Victor Brailovsky and Mikhail Kazachkov. Most, if not all of you, probably are aware: that the human rights organization SOS took its name from Sakharov, Orlov and Shcharansky; that Orlov now is an APS Fellow and a member of the Cornell physics department; and that Shcharansky now is a member of the Israeli Knesset. Most of you probably don't know: that Brailovsky was a computer scientist who, after losing his job in 1972 because he had applied for emigration to Israel, helped organize the Moscow refusnik Seminar on Collective Phenomena; or that in 1980 he was sentenced to five years internal exile in Siberia for defaming the Soviet state. I would be very surprised if any of you know anything about Kazachkov, who still was in his early twenties when I met him during a 1972 visit to Leningrad. Kazachkov's astounding ability to converse with me in almost flawlessly colloquial American English reflected his intense desire to come to the United States, which he repeatedly asked me to help him accomplish. In 1975 Kazachkov received a 15 year prison sentence for allegedly seeking to reveal secrets about his Ioffe Institute to Americans like me, an obviously trumped-up charge which doubtless stemmed from Kazachkov's openly expressed disenchantment with Soviet life. I add that it is my impression that almost all the scientists who were supported by small committee letters were very grateful, although I have no hard statistics to fall back on

As the 1980s drew to a close more and more previously persecuted Soviet scientists were released from prison and/or permitted to emigrate, with the result that the number of Soviet scientists requiring and /or actually receiving small committee support rapidly began to decrease. For instance in 1987, though the committee membership had grown to 256 from its 1985 magnitude of 167, the number of small committees was only 77, a decrease from the 1985 number 84. Moreover as the number of small committees serving persecuted Soviet scientists decreased, the number of small committees serving persecuted scientists of other nations slowly began to increase, reflecting the growing awareness, among the APS membership, of human rights abuses worldwide. Thus in 1989, when the number of small committees had fallen to 62, two of those committees were supporting the Palestinian physicists Sami Kilani and Salman Salman, and a third was supporting the Cuban physicist Jorge Molina.

These just discussed small committee trends were accelerated by the 1989 Tiananmen Square massacre which greatly raised APS membership awareness of Chinese human rights violations, as well as by the collapse of the Soviet Union in 1991. Accordingly, of the 12 new small committees started between November 1989 and March 1990, six were for Chinese physicists and another for a Palestinian physicist; only five of these twelve new committees were for refusniks. Indeed of the ten aforementioned small committees still existing in the year 2000, shortly before the small committee program was dissolved, only a single committee was devoted to a scientist victimized by the former Soviet Union or by one of its daughter republics. The other nine committees were supporting: two Cuban scientists; two Chinese scientists; a Vietnamese; a Palestinian; an Israeli; a scientist from Myanmar; and

an American. Although the vast numbers of scientists oppressed by the USSR during the 1970s and 1980s inevitably caused CIFS to concentrate on aiding Soviet scientists during those decades, from its earliest years CIFS and the APS were attentive to human rights abuses in all nations, including the United States itself, with a total disregard of whether those nations were politically aligned against or with the United States.

In 1980 CIFS' actions during its first year as an APS Bylaws committee included a letter to the Director of the Lawrence Livermore Laboratory concerning the Lab's disciplinary notice to Laboratory physicist Hugh DeWitt, seemingly solely because DeWitt had submitted affidavits opposing the government's attempt to suppress publication by the Progressive Magazine of an article on the H-bomb; apparently it was undisputed that DeWitt's affidavits, as well as the Progressive article itself, were based entirely on sources in the open literature. [DeWitt, who later served as CIFS Chair for the year 2000, has given me permission to use his name. He also has permitted me to tell you he is convinced the CIFS letter was an important factor in the Lab's eventual decision not to actually take any disciplinary action against him.]

The next topic is that of APS letters protesting human rights abuses, the second of my six subheadings; remember I now am excluding any letters written by small committees. During the less than thirty years of CIFS' existence probably several hundred human rights letters have been written (I haven't counted), many by an APS President at CIFS' urging, many others by a CIFS Chair with the President's permission. For the average American, as well as for the APS membership, such letter writing on APS stationery probably has constituted the Society's most widely publicized human rights activity.

Here is a very limited sampling of such letters: During 1977, only a short time after CIFS had been created as a subcommittee of POPA, actions taken by APS President George Pake included letters from him: to the President of Argentina and to Argentine bishops concerning the fate of several disappeared scientists; to President Marcos concerning the imprisoned Philippine physicist Roger Posadas; and to President Ceaucescu concerning two Roumanian physicists whose freedom to pursue their profession had been restricted. Letters after CIFS had been established as an independent Committee included: in 1980, protesting the U.S. government's refusal to allow Soviet scientists to attend an unclassified conference organized by the American Vacuum Society; in 1983, protesting Israel's refusal to permit Palestinian physicists to teach in West Bank universities unless they signed a commitment against "terrorist activities"; in 1983 and 1984, asking UNESCO to investigate and redress Soviet violations of Orlov's human rights; in 1987, protesting the Chilean government's firing of physicist Carlos Infante and other University of Chile faculty; in 1988, well before Fang took refuge in the U.S. Embassy, protesting the Chinese government's refusal to permit Fang to travel to the U.S.; in 1993, inquiring about several professors who were dismissed from Ethiopia's Addis Ababa University for speaking out about a brutal suppression of a student demonstration; and in 2000, decrying U.S. imprisonment of Los Alamos researcher Wen Ho Lee without bail.

Proceeding now to those four other APS human rights activity:

(i) Scheduling sessions on human rights subjects at APS meetings A notable example is the 1981 Annual Meeting in New York, where the Forum on Physics and Society sponsored a CIFS-organized session featuring talks: by an exiled Argentine newspaper editor; by a member of Moscow Helsinki Watch who had just emigrated to this country; and by Congressman George Brown of the House Subcommittee on Science, Research and Technology. Congressman Brown's talk, titled "Science, technology and human rights," quoted Sakharov (who already had been exiled to Gorky), and all in all was a marvelous speech. It was published in the March 1981 Physics Today, and is very much worth reading even now.

(ii) Offering free APS membership and/or journal subscriptions to victimized physicists. This program began in 1979. By 1983 the program had become so expensive that the APS decided to regularly approve half-member rates only. These half-cost subscriptions were made available not only to victimized physicists, however, but also to most third-world physicists and libraries. Moreover unquestionably oppressed scientists continued to receive free subscriptions, via an APS-publicized program of seeking membership donations for such subscriptions. In 1985, for example, there were thirty free memberships of this very special sort. Early recipients of such free Physical Review subscriptions were: Brailovsky's aforementioned refusnik seminar; and Yuri Orlov, though he then still was serving his 1978 twelve year prison sentence, apparently for nothing more than having organized a Moscow Chapter of Helsinki Watch.

(iii) Initiating and/or writing articles describing APS human rights activities, in Physics Today and other publications. In addition to Physics Today's publication of Congressman Brown's talk, there were other such articles on human rights subjects including (and I am listing only a very partial sample): A January 1981 article titled "Soviet repression of dissidents," featuring a photograph of Brailovsky and quoting the views of Kurt Gottfried, the 1980 CIFS Chair; a July 1985 article describing CIFS activities, with a half page devoted to the views of Tom Stix, the 1985 CIFS Chair; and a September 1989 article detailing CIFS' activities on behalf of Tayseer Aruri, a West Bank Palestinian physicist imprisoned by Israel and threatened with deportation.

(iv) Sharing information and otherwise cooperating with non-APS groups seeking to defend human rights. For instance, at quite a number of past APS meetings CIFS has arranged for the Committee of Concerned Scientists (CCS) to set up a table where APS members could sign petitions on behalf of various oppressed scientists selected by CCS. It was CIFS-furnished information about the exaggerations of the government testimony against Wen Ho Lee that convinced Amnesty International to write Judge Parker supporting Lee. Another rather unusual illustration of cooperative activity was my trip to the Soviet Union in 1981 under the joint sponsorship of the APS and various Councils for Soviet Jewry, with the express purposes of: visiting with refusniks in Moscow and Leningrad; giving many of them gifts and publications furnished me by my sponsors; and reporting back to the APS and the Councils about the circumstances of various refusniks whose names I had been given, by CIFS and/or the Soviet Councils. I actually met and reported on as many as 40 refusniks. I won't say anything more about this trip except that possession of state secrets was the Soviet authorities' most common reason for refusing permission for a refusnik to emigrate. Therefore you may be interested in learning that one such refusnik, Lev Blitshtein, was not a scientist but instead had worked in a sausage factory.

I want to emphasize that a significant fraction of the scientists whose human rights we have defended have themselves been

physicists; this is a remarkable observation, especially considering the small percentage of physicists in any nation's population, There really does seem to be something in the culture of our profession, in our insistence on learning how nature truly functions, in our readiness to honor all those who advance this quest no matter what their nationality or the color of their skin, that makes physicists unusually reluctant to quietly accept misuses of state power. Sakharov, Orlov, Galileo, all surely knew that their protests were unlikely to deter their respective political leaders. As physicists, therefore, we must take great pride not only in our Physical Society's defense of human rights, but also in the inspiring fact that so many of the scientists the APS defended have been physicists willing to take actions which can remind future generations of one of the glories of our species, namely that no matter how overwhelming the state power, some humans will refuse to be cowed.

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Einstein, Social Responsibility of Physicists and Human Rights in China

Li-Zhi Fang

(Adapted from paper given at FPS Session, APS Meeting March 2005)

Albert Einstein first became known in China during the period of the May Fourth Movement (1917-1921), which was the first pro-democracy student moment in Beijing. Einstein had been widely respected as a scientific hero who had revolutionized science and our understanding of the universe. During his short visit to Shanghai in 1922-23, he delivered a lecture on relativity on the New Year's Day of 1923[1]. When he went sightseeing in the old city of Shanghai, Chinese students recognized him, carried him on their shoulders, and paraded.

Einstein gained Chinese admiration not only because of his scientific achievements, but also because of his constant concern about the cases of injustice, suppression, and human rights abuses in China. In 1931, the Japanese army invaded and occupied three provinces in Northeast China. Einstein urged all nations to impose economic sanction on Japan. In October 1932, Chen Duxiu, the former dean of the College of Humanities of Beijing University, was arrested. Together with Bertrand Russell, Einstein telegraphed Chinese military authorities and asked for Chen's release. That was the first time that Chinese scholars received human rights support from international intellectual circles. Again, in March 1937, seven intellectuals who advocated resistance towards the Japanese invasion were arrested. Einstein, together with sixteen American intellectual elites, telegraphed the Chinese government and demanded its respect for the freedom of speech and the freedom of assembly.

The strong sense of social responsibility shown by Einstein is an illustrious role model for Chinese intellectuals, especially for physicists, who advocate the universal principle of human rights. In 1937, the Chinese edition of Einstein's "Mein Weltbild" ("The World as I See It") was published. It shows that Einstein devoted his energy against the Nazis. The words "the state should be our servant, we should not be slaves of the state"[2] resonated with many young Chinese, who were facing a crisis similar to that of anti-democratic Fascism due to the full-scale invasion from Japan. For instance, Professor Xu Liangying, a student of Zhejinag University at that time, said that the book "opened up my vision, my mind, my heart and guided me into serious thinking of many fundamental questions in life"[3]. He always carried that book as the whole university withdrew and fled from the war.

Einstein's ideas and opinions on society and politics were not tolerated by the Communists. His words attacking autocratic system were fully banned in Mao Zedong's regime (1949-1976). Pacifism and humanitarianism were also labeled as "Reactionary Bourgeois Class" in nature. During the chaotic period of the culture revolution (1966-1976), there was even a movement specially targeted at Einstein and relativity. In 1970, the communist authorities labeled Einstein as "the most powerful reactionary bourgeois academic authority in the realm of natural science in this century"[4], and tried to convene a congress of 10,000 people to criticize Einstein. However, most Chinese physicists boycotted the criticism of Einstein. Professor Zhou Peiyuan, who spent one year (1937) in the Institute for Advanced Study with Einstein, refused to join the criticism of Einstein. Professor Zhou Tongqing (PhD, 1932, Princeton University) was charged with resisting the criticism, and was denounced at public criticism sessions.

After the Cultural Revolution, Einstein and his relativity were celebrated at the centennial anniversary of Einstein's birthday. The set of three volumes ``The Collected Works of Einstein'', edited by Professors Xu Liangying, Fan Dainian, and Li Baoheng, was published on 1976-79. These volumes had a strong impact on the democracy movement in China. During the Democracy Wall Movement in Beijing (1979-1980), one could read the following statements by Einstein on the Democracy Wall.

"A planned economy as such may be accompanied by the complete enslavement of individual. The achievement of socialism requires the solution of some extremely difficult socio-political problems: how is it possible, in view of the far-reaching centralization of political and economic power, to prevent bureaucracy from becoming all-powerful and overweening? How can the rights of the individual be protected and therewith a democratic counterweight to the power of bureaucracy be assured ?"[5]

The person who posted this statement on the Wall was finally sent to prison for 15 years (1979-1993). In the 1989 Tiananmen movement, one particular quote from Einstein was often heard: "My political ideal is democracy. Let every man be respected as an individual and no man idolized."[5] is one of Einstein's phrases often being quoted. This probably is one of the reasons that among the 21 most wanted students of Tiananmem, 6 were physics majors. Actually, physics students have been deeply involved in all movements of pursuing democracy and freedom. In 1950s, about 10% of the physics students of Beijing University were sentenced to hard labor in the so-called "anti-rightist" campaign.

On Feb. 6, 2005, the Chinese government made public a list of 51 political prisoners who have been granted sentence reductions or are being considered for early release. We know that there is still imprisonment of scientists, such as

1. biologist Yan Jun, who had been given a two-year prison sentence on December 8th of 2003. Yan Jun had written essays

on behalf of the students arrested during the Tiananmen Square incident.

2. geophysicist Yang Zili, who had been given an eight-year prison sentence on November 10, 2003; he founded a discussion group on Chinese political reform, and was charged with inciting subversion of state power.

With this background, we should not forget the social responsibility of physicists as Einstein emphasized "For long periods of time, I have always publicly expressed my opinions on the very bad and unfortunate conditions in the society. Silence would have made me feel guilty of complicity" [6].

[1] Danian Hu, *China and Albert Einstein*, Harvard Press, 2005

[2] A. Einstein, *The World As I See It*, Covici Friede, 1934,

[3] Xu Liangying, Written speech at AAAS meeting on 1995.

[4] Shanghai Science Criticism Group, 1970

[5] A. Einstein, *Ideas and Opinions*, Wings Books, 1954

[6] A. Einstein, *Einstein on Peace*, Simon and Schuster, 1960

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COMMENTARY

Possible Solution for the Two Brain Syndrome

David Griffiths

In a recent commentary (P&S, January 2005), A. M. Saperstein expressed concern at the tendency of his students to use two modes of thought–an "in-school brain" for science classes and an "out-of -school brain" for the rest of their lives. This gap has severe implications for our society. It implies that the students (and most citizens) cannot be expected to understand issues such as nuclear proliferation or global warming. The question arises, why does this two brain syndrome occur?

When my children went though junior and senior high school science classes I was appalled at the course content. The tendency was to present science as a set of absolute truths handed down by higher authorities. There was, of course, always a paragraph or two on the scientific method, but this was forgotten as quickly as possible. The courses drowned the students in a flood of "facts", concepts and canned calculational procedures. In this situation the students could hardly be expected to appreciate the beauty and honesty of science. It was all they could do to survive from test to test. A quick perusal of high school science texts suggests the situation has not improved, and in fact the problem seems to be well known. The Director of the American Association for the Advancement of Science Education Project (Project 2061) commented that "Surprisingly, although the [high school biology] textbooks are filled with pages of vocabulary and unnecessary detail, they provide only fragmentary treatment of some fundamentally important concepts" (*http://www.project2061.org*).

In a recent NY Times article (Op. Ed. May 6th, 2005), Thomas Friedman, author of "The World is Flat", remarks that "learning how to learn" is a key skill for the future. This requires that students gain the ability to distinguish honest from dishonest reasoning. Ideally physics should give the students a shining example of honest reasoning at its best. But what defines honest reasoning? It is certainly more than avoiding outright lies.

The idea of an honest reasoning (or proof) was pioneered in mathematics and led to the axiomatic approach, the key components being:

-Specification of the legitimate area of argument (geometry, laws of nature, morality, …..)

-Clear definition of the meaning of the terms used (point, line, mass, God, justice,….)

-An agreement as to the method of reasoning (Aristotelian logic, analogy,…)

-A statement of all assumptions & principles used (Occam's razor, literal interpretation..)

-Consistency, that is, it should not be possible to prove a statement and its converse

Consistency is a key aspect of honesty. A well known example is Galileo's logical demonstration of the inconsistency of Aristotle's statement that heavy objects fall faster than light objects. (Galileo Galilei, "*Two New Sciences*", Dover Publication, page 64). Galileo points out that if you attach a light object to a heavier object to form a composite object then, you can argue both that the composite object falls faster than the heavy object, and that it falls slower than the heavy object. This inconsistency leads Galileo to conclude that the rate of free fall cannot depend on the mass (neglecting air resistance). The experimental demonstration is, however, more convincing than the logical demonstration.

The results of honest reasoning will depend on the starting assumptions. For example, one characteristic of scientific theories is that they typically assume the principle of uniformity, that is, the laws of nature are assumed to hold everywhere and for all times. This assumption is not provable, but might be called definitional, rather as Euclid's parallel postulate is not provable but is part of the definition of Euclidean geometry. Change the parallel postulate and you get a different but equally honest geometry. In the same way it could be argued that an honest religious estimate of the age of the universe might be different from a scientific estimate if the religious theory substitutes literalism for the principle of uniformity. Even Newton tried to estimate the age of the earth using a literal interpretation of the Bible for dating purposes. However, while the initial assumptions are not subject to logic, for honest reasoning you would expect the assumptions to be consistent. However, a consistent literal interpretation of the Bible leads to the view that the earth is flat, and that the sky consists of an immense dome (firmament) with holes or doors to allow the rain to fall. Scholarly books on the Bible sometimes provide fairly detailed pictures of this model (for example, L. Boadt, "*Reading the Old Testament*", Paulist Press, page 115) The honest literalist is thus faced with the problem that literalism leads to a conclusion contradictory to everyday experience. So to be honest the literalist must either drop the principle of literalism, use it selectively, make it vague, or deny everyday experience.

While I doubt that any system of physics education could com-

pletely cure the two-brain syndome, I think we could improve the situation by reforming introductory physics courses. The amount of material should be reduced, and more emphasis should be placed on history, scientific reasoning, and the resolution of scientific controversies (this is where reasoning becomes interesting). The development of the heliocentric model and Newtonian mechanics could provide a fascinating case study of a controversy in the past. Global warming provides a contemporary example of the application of physics to a "controversial" issue. While the scientific consensus is that global warming is real and driven by CO2 emissions, powerful interest groups resist this conclusion, and the general public is confused. An introductory physics could demonstrate how honest reasoning applies to global warming, and should also be able to show the students the importance and relevance of key concepts such as the 2nd Law of Thermodynamics, the absorption spectrum of CO2, and black body radiation.

In short, my view is that the best course of action to improve the "two brain" syndrome is to teach introductory physics as a shining example of the application of an honest brain to difficult and controversial topics.

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The Role Of Faith

Emily Glad

As someone who believes in God and the eternal truths of His Word, I find it hard to reconcile modern scientific thought with the Biblical account of Creation. In this regard, I am not unlike many other Christians. Believers often find themselves fractured over this issue. There are two basic camps of thought within the religious community: Those who believe in the literal seven-day creation account of Genesis and those who believe in a symbolic rather than literal interpretation of Genesis. At its core is the often-heated debate between those who believe in a young earth and those who believe in an old earth.

But why has this issue become such a litmus test for believers? In fact, the issue is so divisive that many who subscribe to the young earth theory would go so far as to question whether or not those who accept the old earth theory have a genuine faith. Their fear is that the rest of the Bible's authority would be undermined if the opening chapter were not interpreted literally. But in fact, each camp is so blinded by its own understanding of what is true that neither can see the fact that on the most important issue their is no disagreement between them: Each equally embraces the unexplainable mystery of creation, albeit both choosing to explain this mystery in dramatically different ways.

Amidst this debate I find myself grappling with the very same issues. Why is it that my fellow believers and I must know the age of the earth, and why must there be such dissension when we have differing points of view? We all agree that "In the beginning, God created the heavens and the earth," but somehow we've lost sight of that being the most important thing. At the heart of the issue is how strong our faith as believers actually is. And the question I must ask myself is this: Does my faith in God take priority over man's ability to explain rationally the world He has given to us? I would hope that it does. Because it is this faith alone that provides me with a meaningful existence. Despite the progress science has made in its ability to explain the world around us, it will always be limited in its explanatory power. After all, scientists are human just like the rest of us, and are we not all limited by our own humanity? I would hope that despite man's best efforts to prove scientifically a young earth or an old earth, he would not forget that there are eternal mysteries of the universe that we will never understand, despite all the rational, logical thought in the world.

I find the universe to be awe-inspiring. But when confronted with the cold calculated numbers of science, the cosmos becomes a vast, lonely place devoid of hope, and I feel overwhelmed by a feeling of insignificance. At such a moment the only thing I have that has any meaning at all is my faith. And I believe that is exactly where God wants me to be, fully relying on Him for understanding. Science cannot prove the existence of God. The question of His existence is far too abstract to be scientifically proved or disproved. Yet that does not discredit my belief in Him. God's existence makes perfect sense to me, and not only to me, but also to countless other believers at every intellectual level. I have no scientific proof, but I have a personal conviction of His presence.

In reality for me it's not so important how old the earth is. Humanly speaking it would be comforting if I had a definitive answer. But ultimately, what's more important is that I have a faith that can hold fast despite all the answers that I don't have. Comforting thoughts and easy explanations are not promised to believers any more than they are to the rest of mankind. The noted author and critic C.S. Lewis put it well when he said:

"It is a profound mistake to imagine that Christianity ever intended to dissipate the bewilderment and even the terror, the sense of our own nothingness, which come upon us when we think about the nature of things. It comes to intensify them. Without such sensations there is no religion. Many a man, brought up in the glib profession of some shallow form of Christianity, who comes through reading Astronomy to realise for the first time how majestically indifferent most reality is to man, and who perhaps abandons his religion on that account, may at that moment be having his first genuinely religious experience."

We are none of us so privileged as to hold the answers to the mysteries of the universe. It would be pure arrogance to think so. In this regard, the scientist and the believer share the same position. Brilliant men, such as Einstein, rather than becoming puffed up by their accumulation of knowledge have found themselves humbled by the unexplainable. A good scientist should always allow the room to believe in something, and to concede to the fact that there is more going on than we can possibly ever know. Because of this I recognize the danger of putting all of my trust in the strength of man's arguments. If I were to only believe what men tell me, I would never fail to be disappointed. But if I put my faith in God, acknowledging that His ways and thoughts are higher than my own, how can I ever be troubled by the ever-changing knowledge of man? This is not some blind faith that recklessly abandons all sensible thought, but rather a faith that embraces the peculiar and limited position of mankind.

I believe that it is in the beauty of the unexplainable that faith is found. Rationality is a gift from God, but it should never replace the need for God. Nor is it necessary that all rational thought be scientific thought. The two are not mutually exclusive. But it is necessary that

our rational thought does not prevent us from seeing the larger picture. A person of true faith should be careful to view the knowledge of man through the lens of God's eternal truths. Likewise, the community of faith must be careful not to become so entangled in debates over the age of the earth that it loses sight of the beautiful and unexplainable mysteries of God's universe.

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School Boards Want to 'Teach the Controversy.' What Controversy?

Lawrencee M. Krauss

The recent so-called debates on the teaching of evolution in Kansas have me thinking about different theological reactions to the teaching of evolution.

The Roman Catholic Church, which stands on common ground with conservative Christians in opposition to abortion, and which is doctrinally committed to notions like the Virgin Birth, apparently has no problem with the notion of evolution as it is currently studied by biologists, including supposedly "controversial" ideas like common ancestry of all life forms.

Popes from Pius XII to John Paul II have reaffirmed that the process of evolution in no way violates the teachings of the church. Pope Benedict XVI, when he was Cardinal Joseph Ratzinger, presided over the church's International Theological Commission, which stated that "since it has been demonstrated that all living organisms on earth are genetically related, it is virtually certain that all living organisms have descended from this first organism."

At the same time, those who wish to include "intelligent design" in the science curriculum insist that if we leave the creator out of discussions of the origin and evolution of life, then such "naturalism" must be incomplete - and that it opens the door to moral relativism and many of the other ills that go along with it.

The ultimate extension of this position may be Representative Tom DeLay's comment that the tragedy at Columbine happened "because our school systems teach our children that they are nothing but glorified apes who have evolutionized out of some primordial mud." Evolutionary biology is not the only science that appears to raise theological issues.

As a cosmologist, I am reminded of a controversy that arose from the development of a consistent mathematical solution of Einstein's equations, devised in 1931 by Georges Lemaître, a Catholic priest and physicist.

The solution required what today we call the Big Bang. By confronting the conventional scientific wisdom that the universe was eternal, and instead demonstrating that it was likely to have had a beginning in the finite past - indeed, one that could certainly be said to be born in light - Lemaître was hailed by many, including 20 years later by PopePius XII himself, as having scientifically proved Genesis.

Lemaître, however, became convinced that it was inappropriate to use the Big Bang as a basis for theological pronouncements. He initially inserted, then ultimately removed, a paragraph in the draft of his 1931 paper on the Big Bang remarking on the possible theological consequences of his discovery. In the end, he said, "As far as I can see, such a theory remains entirely outside of any metaphysical or religious question."

"While this argument may seem strange, Lemaître was grasping something that is missed in the current public debates about evolution. The Big Bang is not a metaphysical theory, but a scientific one: namely one that derives from equations that have been measured to describe the universe, and that makes predictions that one can test.

It is certainly true that one can reflect on the existence of the Big Bang to validate the notion of creation, and with that the notion of God. But such a metaphysical speculation lies outside of the theory itself.

This is why the Catholic Church can confidently believe that God created humans, and at the same time accept the overwhelming scientific evidence in favor of common evolutionary ancestry of life on earth.

One can choose to view chance selection as obvious evidence that there is no God, as Dr. Richard Dawkins, an evolutionary biologist and uncompromising atheist, might argue, or to conclude instead that God chooses to work through natural means. In the latter case, the overwhelming evidence that natural selection has determined the evolution of life on earth would simply imply that God is "the cause of causes," as Cardinal Ratzinger's document describes it.

The very fact that two such diametrically opposed views can be applied to the same scientific theory demonstrates that the fact of evolution need not dictate theology. In other words, the apparently contentious questions are not scientific ones. It is possible for profoundly atheist evolutionary biologists like Dr. Dawkins and deeply spiritual ones like Dr. Kenneth Miller of Brown University, who writes extensively on evolution, to be in complete agreement about the scientific mechanism governing biological evolution, and the fact that life has evolved via natural selection.

Students are completely free to make up their own minds, in any case. What is at issue is whether they will be taught the science that should allow them to make an informed judgment. But impugning the substance of the science, or requiring the introduction of essentially theological ideas like "intelligent design" into the curriculum, merely muddies the water by imposing theological speculations on a scientific theory. Evolution, like Lemaître's Big Bang, is itself "entirely outside of any metaphysical or religious question."

The Discovery Institute, which promotes "intelligent design," a newer version of creationism, argues that schools should "Teach the Controversy." But there is no scientific controversy.

State school board science standards would do better to include a statement like this: While well-tested theories like evolution and the Big Bang have provided remarkable new insights and predictions about nature, questions of purpose that may underlie these discoveries are outside the scope of science, and scientists themselves have many different views in this regard.

Or one might simply quote Lemaître, who said of the limitations of science and of his own effort to reconcile his scientific discoveries with his parallel religious beliefs: "To search thoroughly for the truth involves a searching of souls as well as of spectra."

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Dr. Lawrence M. Krauss is chairman of the physics department at Case Western Reserve University. His new book, "Hiding in the Mirror," will appear this fall.

LETTERS

Hans Bethe and Nuclear Power

April 24th 2005

The Editor, Science and Society

Dear Sir,

I must disagree most strongly with the implication by Professor Salpeter in your April issue that Hans Bethe was being a moderate liberal scientist in his discussions of nuclear bombs but not being a moderate liberal scientist when he supported the development of nuclear electric power and disagreed with the positions taken on nuclear power by the Union of Concerned Scientists from 1973 on. It is an interesting paradox that in the 1960s it was liberals, usually Democrats, who supported nuclear power development and Republicans who were reluctant. Now liberals, although mostly not liberal scientists, have rejected nuclear power and by default the globe may be warming somewhat faster! To many of us, the Union of Concerned Scientists was, in 1973, incorrect and counterproductive. By taking a very public position against nuclear power, UCS deflected attention from their important position of opposition to the arms race. Bethe remained consistent. While arguing for a strong control of, and reduction in the number of nuclear bombs, he supported civilian uses of nuclear fission. His logical, and in my view liberal, position was made clear in the statement of which he was the architect "Scientists' Statement on Energy Policy" in 1975. Hans felt that there were, and are, legitimate concerns about nuclear power that had to be, and have to be, addressed, and was willing to address them.

Hans had thought carefully about the safety of liquid sodium reactors in the 1960s and "invented" the "Bethe-Tait" accident whereby, after a loss of sodium coolant, the top of the reactor fuel assembly falls to the bottom with a velocity great enough to make a considerable reactor excursion. Until the 1980s this was the dominant safety worry. Fortunately this is avoided in modern designs, with metal fuel, by a natural shut down before the likely accident initiators can evaporate the sodium. In 1975 Hans gave a lecture on the Breeder Reactor at Fermilab. In the question period I criticized him for ignoring some specific safety issues. His reaction was characteristic. He telephoned me the next day and asked me to join a small committee on Breeder Reactor Safety the AEC had just asked him to form. Although I had of course admired Hans Bethe since my undergraduate days, and first met him in 1950, this was when our friendship began. When in 1983 Charles Till at Argonne National Laboratory came up with the idea of the Integral Fast Reactor, which has the potential to reduce the proliferation worries of the Purex fuel cycle, both Hans and I served on the advisory committee. Hans was characteristically enthusiastic, was meticulous about editing our draft reports to ensure the correct balance of optimism and reality and was constantly emphasizing the importance of preventing proliferation. Health prevented Hans from coming to some of the later meetings, and in 1995 the IFR program was abandoned, hopefully only temporarily, but I still discussed with him all my thoughts on nuclear energy on my many visits to Cornell for colliding beam physics.

Nor is it correct that Hans has had no input into problems such as nuclear waste. In one of my many discussions in late 1997, Hans mentioned that an Indian tribe (the Skull Valley Band of Goshutes wanted to store nuclear waste (temporarily) in their back yard. This would enable spent fuel to be stored with an even smaller risk than in the reactor complex. By January 13th 1998 I had formed Scientists for Secure Waste Storage—with 6 Nobel Laureates, 2 Ambassadors, an astronaut and a Presidential Science advisor to support the tribe's efforts in the long public hearing. There was, and is, opposition. Hans always wanted to know the progress. I had hoped to be able to tell him of even partial success. But it was just a week after Hans' death that the Atomic Safety and Licensing Board recommended approval (although there are still many avenues open for opposition).

Hans was a conciliator. When in 1988 half a dozen liberal Nobel laureates were upset with the Union of Concerned Scientists for using their names (as they had used Hans' name) in a position paper against nuclear power, and one was threatening legal action, it was Hans who calmed them down. In 1997 at an energy conference held by the Global Foundation, it was my privilege to be Chairman at the final panel session on nuclear power. Hans and Edward Teller, who disagreed on military uses of nuclear energy, expressed complete agreement with each other on the need for nuclear power. I understand it was the first time their wives, who were present at the meeting, had talked to each other for 20 years.

In honoring and remembering Hans we must not forget the power, strength and support of his wife Rose (Ewald). Although not cognizant of details of our technical discussions, she understood the principles. Rose and her parents understood the evils of fascism even better than Hans, and it was principally Rose who shared with us her deepest concerns about the trend of the US government. I had followed the terrible events of the 1930s from across the English Channel and share their concens.

We in physics have lost a mentor and friend. We give our sympathy to Rose who has lost much more.

Yours sincerely
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NEWS

Report on Initial Employment in Physics and Astronomy

Over half of the new physics PhDs in 2002 accepted postdoctoral positions, and about half of the new physics bachelors started graduate school, according to a recent survey by the American Institute of Physics' Statistical Research Center. The report looks at the initial employment of graduates from the physics and astronomy classes of 2001 and 2002 at U.S. colleges and universities.

In the U.S., 1157 physics PhDs were produced in the class of 2001,and 1095 in 2002. This represents "the seventh and eight year of declining physics doctorate production" in this country, according to the report. The survey received information on 63% of the degree recipients from these classes. Respondents reported "a median of 6 full-time equivalent years of study to complete

their degree. "According to the survey, 50% of those PhDs were foreign citizens and14% were women. Responses indicated that approximately 15% of the foreign students left the U.S. after receiving their degrees.

Only two percent of the combined classes reported being unemployed in the winter after receiving their degree. The survey finds that "the proportion of new physics PhDs taking postdocs has risen for the second consecutive year," largely due to "a sharp increase in the proportion of foreign citizens" from the 2002 class accepting postdoctoral positions.

According to the report, the highest starting salaries were received by PhDs accepting potentially permanent positions in the private sector and at national laboratories, with salaries at colleges and universities "strikingly lower than in other potentially permanent positions." Survey responses also indicated that, "overall, physics PhDs are quite satisfied with their initial employment circumstances."

Undergraduate physics degree production "has increased significantly" in the U.S. in recent years, the report says. In 2001, 4091 physics bachelor's degrees were conferred, and 4305 were conferred in 2002, representing "an 18% increase over the recent low of the class of 1999." The combined classes of 2001 and 2002 included 23% women and 6% foreign citizens. Of those graduates, 59% of the respondents indicated satisfaction with the job market and available career prospects, and 85% of respondents "indicated that they would still major in physics."

"As has been the case for many years," the survey says, "about half of the new physics bachelors go directly to graduate school." Of those going into the job market, the survey finds that the private sector "continues to be the dominant employer," but "now employs less than half of all physics bachelors" in the combined 2001 and 2002 classes. "The government sector and high school teaching have seen the greatest growth in recent years," the survey finds.

In 2001, 701 physics master's degrees were conferred, declining to 657 in 2002. The combined classes for the two years included 20%women and 39% foreign citizens. Responses indicated that almost a third of those graduating with a master's degree "continued with physics graduate study at another institution." The survey reports that "a little over half of the masters, made up of predominantly U.S. citizens, indicated that they had entered directly into the workforce," where the private sector continues to be the largest employer of new physics masters. The survey also finds that, "for the most part, physics masters felt good about their choice of major(85%), but not as positive about the job market and career options, with 40% expressing dissatisfaction."

In astronomy, the PhD classes of 2001 and 2002 included "101 and 102 students, respectively," with 24% women and 27% foreign citizens in the combined classes. Almost three quarters of the combined PhD classes reported accepting postdoctoral appointments. The survey finds that "astronomy PhDs felt very positive about their degree and employment situation."

Bachelor's degree production in astronomy has seen a "dramatic rise that began with the class of 2001," according to the report, which finds that "much of this increase coincided with a sharp rise in the number of women receiving astronomy bachelor's degrees." The class of 2001 produced 274 astronomy bachelors, and the class of 2002 produced 325, with 42% women and 6% foreign citizens in the combined classes. Of the respondents in these classes, about half began graduate school, and the other half entered the workforce, with the private sector as the largest employer. While 81% indicated that they would choose an astronomy major again, the report notes that "astronomy bachelors were less positive about the job market they encountered."

"The population of exiting master's degrees in astronomy is very small," the report says, "too few to allow detailed analysis of outcomes. Most of this group entered directly into the workforce."

The March 2005 report, entitled "Initial Employment Report: Physics and Astronomy Degree Recipients of 2001 and 2002," (AIP Pub. No.R-282.24), can be found at http://www.aip.org/statistics/trends/reports/emp0102.pdf.

AIP's Statistical Research Center collects and maintains data, and produces reports, on a broad range of education, workforce and demographic issues within the physics and astronomy communities. Highlights and the full text of reports can be found on the AIP website at http://www.aip.org/statistics/.

FYI
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Senator Hutchison Seeks Broader Role for Space Station

"I am especially concerned that we build our path to the future without short-changing the investment we have made in the exploration tools we already have in hand." -Sen. Kay Bailey Hutchison (R-TX)

The chair of the Senate Commerce Subcommittee on Science and Space, Kay Bailey Hutchison (R-TX), wants to find a way to ensure that research on board the International Space Station (ISS) fulfills many of the promises that have been made for it over the years. While supportive of President Bush's Vision for Space Exploration, at an April 20 hearing she stated her commitment "to ensuring that the investment we have made as a nation in the International Space Station is rewarded to the greatest extent possible by the fulfillment of the purposes for which it has been designed.... This important, impressive facility cannot be allowed to be used simply as a tool for Moon and Mars exploration-related research," she declared. "This facility is capable of doing much more for our nation...and we must ensure that we make the maximum use of its capabilities." As input to her preparations for a NASA reauthorization bill, she probed witnesses for suggestions on management models that might let the U.S. continue with a broad range of research objectives for the station.

Marcia Smith of the Congressional Research Service reviewed the station's history since it was originally proposed by President Reagan in 1984. She noted that when the program began, it was expected to serve eight separate functions: as a laboratory; a permanent Earth and space observatory; a transportation node; a facility for servicing, assembling, manufacturing, and storing components, payloads and vehicles; and a staging base for future missions. Under the first President Bush, the station was downsized and limited to one remaining role, a laboratory in space. Further rounds of downsizing and cost-cutting followed under Presidents Bush and Clinton. In 1993 the Russians joined the international partnership, and in 1998 the first two elements were launched. After taking office in 2001, the second President Bush cancelled

three major U.S. elements, including the Crew Return Vehicle, reduced the research budget, and called for prioritization of the research program by the Research Maximization and Prioritization (ReMaP) Task Force. Then, in his Vision for Space Exploration, announced in January of last year, the President stated that "we will focus our future research aboard the station on the long-term effects of space travel on human biology." The full extent of the impact of President Bush's vision on the utilization of the ISS "is not clear yet, "Smith said. "What is known," she added, is that "the scope of research would be narrowed," there would be "fewer years during which NASA would conduct research," and "the shuttle would not be available" to support scientific operations after the station is completed.

In prepared testimony, William Readdy, NASA's Associate Administrator for Space Operations, stated that "U.S. research activities aboard the Station will be focused to support the new exploration goals." He informed the subcommittee that "NASA is currently in the process of focusing and prioritizing International Space Station research and technology development efforts on areas that best contribute to the Vision." He continued, "In order to best utilize limited resources, NASA is phasing out some activities that do not directly support the Vision...and reallocating resources to the higher priority areas." Readdy reported that, prior to President Bush's announcement of the new exploration goals, NASA had studied possible management options for long-term ISS utilization. But, he said, those studies were suspended after Bush's announcement.

Hutchison asked for the preliminary findings of these studies, to aid her in preparing a reauthorization bill for the space agency. She and other subcommittee members questioned the witnesses about possible management models for long-term ISS research, the prospects for private investment, the most appropriate types of research, and U.S. access to the station after the shuttle is retired. Some management options mentioned included designating the ISS a national laboratory, operating it as a federally-funded R&D center or a research institute, or management by consortium. While stating that a balanced, overall program of science, exploration and aeronautics must "capitalize on the unique testbed" offered by the ISS, Jeffrey Sutton of the National Space Biomedical Research Institute cautioned that NASA must be "more selective in the types of experiments flown" on the station. He urged decision makers to ask, "What can only be done on the space station?"

"Selecting which experiments get to fly" is a significant challenge, agreed Mary Ellen Weber of the University of Texas, Southwest Medical Center. This can only be determined, she said, by first deciding what the station's mission is: Is it intended to be a conduit for private-sector commercialization of products? Or is it intended to serve the national interest, by supporting the space exploration initiative, for example? She highlighted two areas of research that she thought would reap substantial rewards for private investors: the growth of human tissue outside the body, and the growth of protein crystals to advance drug design based on the structures of protein molecules. Weber, whose past work at NASA included efforts to attract private investment to space research, offered a number of "lessons learned." The space agency must make "a paradigm shift," she said, and begin to take the responsibility for surveying the market place, identifying a compelling market need, ensuring a specific source of revenue, and developing a business plan ,rather than "put[ting] the onus on investors."

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AAPT Statement on the Teaching of Evolution and Cosmology

Threats to the teaching of high-quality, peer-reviewed science continue to arise in school districts around the country. "Although the controversy focuses primarily on biology," National Academy of Sciences President Bruce Alberts warned Academy members earlier thisyear that "some who challenge the teaching of evolution in our nation's schools have also focused their sights on the earth andphysical sciences" (see *http://www.aip.org/fyi/2005/049.html*).

The American Institute of Physics (AIP) and many of its Member Societies have been active in monitoring this issue and, in some instances, taking actions to defend the teaching of high-quality science in science classrooms. To address efforts "to weaken and even to eliminate significant portions of evolution and cosmology" from state and local educational objectives, the Executive Board of the American Association of Physics Teachers, an AIP Member Society, recently adopted a statement on the teaching of evolution and cosmology. The text of the April 24 statement follows:

"AAPT Statement on the Teaching of Evolution and Cosmology

"The Executive Board of the American Association of Physics Teachers is dismayed at organized actions to weaken and even to eliminate significant portions of evolution and cosmology from the educational objectives of states and school districts.

"Evolution and cosmology represent two of the unifying concepts of modern science. There are few scientific theories more firmly supported by observations than these: Biological evolution has occurred and new species have arisen over time, life on Earth originated more than a billion years ago, and most stars are at least several billion years old. Overwhelming evidence comes from diverse sources - the structure and function of DNA, geological analysis of rocks, paleontological studies of fossils, telescopic observations of distant stars and galaxies - and no serious scientist questions these claims. We do our children a grave disservice if we remove from their education an exposure to firm scientific evidence supporting principles that significantly shape our understanding of the world in which we live.

"No scientific theory, no matter how strongly supported by available evidence, is final and unchallengeable; any good theory is always exposed to the possibility of being modified or even overthrown by new evidence. That is at the very heart of the process of science. However, biological and cosmological evolution are theories as strongly supported and interwoven into the fabric of science as any other essential underpinnings of modern science and technology. To deny children exposure to the evidence in support of biological and cosmological evolution is akin to allowing them to believe that atoms do not exist or that the Sun goes around the Earth.

"We believe in teaching that science is a process that examines all of the evidence relevant to an issue and tests alternative hypoth-

eses. For this reason, we do not endorse teaching the "evidence against evolution," because currently no such scientific evidence exists. Nor can we condone teaching "scientific creationism," "intelligent design," or other non-scientific viewpoints as valid scientific theories. These beliefs ignore the important connections among empirical data and fail to provide testable hypotheses. They should not be a part of the science curriculum.

"School boards, teachers, parents, and lawmakers have a responsibility to ensure that all children receive a good education in science. The American Association of Physics Teachers opposes all efforts to require or promote teaching creationism or any other non-scientific viewpoints in a science course. AAPT supports the National Science Education Standards, which incorporate the process of science and well-established scientific theories including cosmological and biological evolution.

"This statement was adopted by the Executive Board of the American Association of Physics Teachers on April 24, 2005."

In cooperation with many of its Member Societies, AIP continues to track attempts around the country to dilute the science taught in science classrooms. In some instances, AIP and several Member Societies have initiated such responses as writing letters to school boards and state and local officials, encouraging individual scientists to testify at hearings, issuing news alerts, and encouraging other grassroots initiatives.

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All above by:
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Does National Security Require or Contradict Scientific Integrity?

Unknowns at MIT

The new president of the Massachusetts Institute of Technology, Susan Hockfield, has an opportunity she should not miss to put the institute on the right course in a matter that affects national security, the integrity of scientific research, and the institute's ability to maintain academic independence while receiving millions of dollars in research funds from the Defense Department.

After years of delay, her predecessor, Charles Vest, had acknowledged evidence suggesting a possible coverup of scientific fraud involving Lincoln Laboratory and early tests of the national missile defense system. An MIT inquiry had come to this conclusion last year, and, in accordance with federal rules and MIT policies, it recommended opening an investigation by MIT to determine whether there had indeed been scientific misconduct at Lincoln Laboratory, a federally funded research and development center over which MIT has supervisory responsibility.

But just before he left office last December, Vest suspended the investigation after the Missile Defense Agency informed MIT that it was classifying both MIT's inquiry and a 1998 Lincoln Lab report to federal investigators that is suspected of falsifying results of the first test flight, in 1997, of the missile defense system now being deployed.

Hockfield would be acting in the best interests of MIT and the country if she invested her prestige in persuading the Pentagon to reconsider its classification of materials that MIT's investigators have the security clearances to see. She should also approve creation of a panel of independent investigators —people who have the technical and scientific background to judge the evidence and who have no ties to the Pentagon or MIT that might suggest a conflict of interest. Ideally, such a panel would be allowed to see the materials the Missile Defense Agency has now classified. But if not, some scientists contend that there is enough material in open, unclassified sources to determine whether there was a crucial failure of the infrared sensor in the first test of the missile defense system and whether the Lincoln Lab covered up that failure in its 1998 report.

This is a matter that goes beyond MIT's oversight of Lincoln Lab or its relations with the Pentagon. Because the Bush administration is betting that the system can protect Americans from nuclear attack by intercontinental ballistic missiles, Hockfield is also confronting a question that involves the security of all Americans as well as the economic wisdom of Bush's missile defense gamble. MIT officials have not responded to several requests for comment.

For several years, the MIT physicist Ted Postol, a professor of science, technology, and national security policy, has been calling for the institute to investigate the possibility that Lincoln Laboratory covered up fraud by the defense contractor TRW. In 1997 and 1998,TRW conducted early experiments for the missile defense system. A whistleblower from TRW later told the Defense and Justice departments that TRW tampered with data analysis, making it appear that the warhead in those tests was selected from among several decoys by an infrared sensor when in fact it was not. Plausible decoys were removed from subsequent tests. The sensor's ability to tell decoys from a warhead is crucial for a missile defense system because any country able to launch a nuclear weapon on a missile will also be able to surround it with decoys.

Federal agents looking into the whistleblower's charges asked Lincoln Lab for an analysis of the early TRW flight tests. In the summer of 1998, Lincoln Lab delivered to investigators from the Justice Department and the Defense Department a report entitled "Independent Review of TRW Discrimination Techniques." The 1998 Lincoln report claimed that the sensor had discriminated between the decoys and the mock warhead. But two reports produced in 2002 by the General Accounting Office (now the Government Accountability Office) found several flaws in the sensor caused by a failure of its cooling system. As a result, the sensor lost calibration, meaning that it could not match what it saw to what it was programmed to expect.

Like Postol, David Wright, senior scientist and codirector of the Global Security Program for the Union of Concerned Scientists, says that if such a failure prevented the sensor from cooling sufficiently, it could not have discriminated between a warhead and decoys, as TRW and the Lincoln Lab report claimed. The director of the Carnegie Endowment's nonproliferation project, Joseph Cirincione, says that Lincoln Lab "had the data and appeared to cherry-pick the data. It looks very clear to me."

A key question hovering over the argument between Postol and MIT's administration is whether it is possible to decide the question of scientific fraud at Lincoln Lab while its1998 report and the

MIT inquiry are classified. Postol insists there is ample unclassified material that is "all over the Web."

Phillip Coyle, who was assistant secretary of state for test and evaluation from 1994 to 2000, believes, however, that it would be better for all concerned parties if the relevant materials were made available to investigators with the requisite security clearances. If an investigation is done without access to classified materials and it does not prove fraud, Coyle says, Postol and others who suspect fraud will be back to square one. If the Pentagon says that the key reports are classified or that people with the right clearances can't see them, Coyle contends, that raises questions about the level of trust between MIT and the Defense Department.

Cirincione explains MIT's lack of ardor to obtain a definitive answer to the question of fraud by saying, "They are seekers of contracts, not seekers of truth." The challenge facing Hockfield did not originate on her watch, but she would be wise to address it forthrightly by insisting that the Pentagon allow a panel of independent, qualified people to examine the records and decide whether a scientific fraud has been committed involving a system that is supposed to protect Americans from a nuclear warhead.

Editorial "Unknowns at MIT"
Boston Sunday Globe, April 10, 2005
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REVIEWS

Protecting the Ozone Layer: Science and Strategy

By Edward A. Parson, Oxford University Press, 2003, 400 pages, ISBN 0-19-515549-1, $74.50

The recognition of the threat posed to the ozone layer by chlorofluorocarbons (CFCs), and the international treaties that have been in effect during the past two decades to alleviate this problem, have been considered by many to be a uniquely important example of efforts by the global community to deal with human effects on environmental problems that are intrinsically global in scope. This book is a comprehensive study of how scientists first determined that these seemingly benign chemicals were so dangerous and how the international community eventually agreed on ways to virtually eliminate the emission of CFCs into the atmosphere. A critical examination of how and why CFCs have been successfully regulated may provide lessons on how to deal more effectively with the regulation of emission of carbon dioxide and other global warming gases.

Edward A. Parson was a professor of public policy at Harvard University when he wrote this book; he currently holds joint appointments in Michigan University's Law School and School of Natural Resources and Environment. His research has concentrated on the study of this and related issues and this book is a very detailed and technical study of the ozone issue.

Some have argued that control of CFC emission is a special case where the danger was clear and the solution relatively easy and therefore there is little to be learned with respect to other global environmental problems. Parson argues that although there are clearly some unique aspects to the ozone case there are many features that have more widespread applicability. Indeed a considerable portion of this book is devoted to examination of the many obstacles and delays that initially frustrated attempts to come to terms with the ozone depletion problem. For example, Parson notes that there was an initial decade of relatively fruitless discussion and negotiation that included debates about whether there was any clear scientific evidence of a problem. He also describes claims that were made that severe technological and economic problems would result if attempts were made to reduce, let alone eliminate, CFC emissions.

One of the most interesting parts of this book is the discussion of particular methods and procedures that eventually led to international agreement on the near-elimination of CFC emission and use. Parson clearly documents the importance of authoritative scientific assessment. The scientific evidence of depletion of the ozone layer due largely to CFC emission had eventually become clear to most of the researchers themselves but was less obvious to those who had to negotiate and set regulatory policy. It required a careful review of the available research by a group of recognized experts from several different countries before there was general agreement about the nature and scope of the problem. Once this had been achieved the world community was faced with the difficult task of negotiating a regulatory treaty that would gain initial approval from the major CFC-consuming and -producing countries and would also be amenable to change when new technical data became available.

Of particular interest is the "adaptive regime" that set machinery in place that was particularly effective in assessing new scientific research, and the exchange of information about the production of new chemicals that could safely replace the CFCs and other ozone depleting materials. These mechanisms provided the structure that allowed an ongoing evaluation of the situation, and a forum to facilitate negotiations for more effective control of ozone depleting chemicals.

This is a valuable book, particularly for those interested in having an effective impact on public policy that is driven by scientific research and evaluation. It provides enormous detail and annotation; there are almost 90 pages of footnotes. This does not always make for easy reading, particularly for those who are not experts in public policy. The general reader may be most interested in Chapters 1, 2 and 9 and might wish to skim much of the discussion in the other chapters dealing with the fine details of the issue and the negotiations that led to the adoption of the current stringent controls on CFC production and emission. Nonetheless, any expert or layman interested in how to effectively deal with global environmental problems will find much to learn from this study.

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The Four Faces of Nuclear Terrorism

by Charles D. Ferguson and William C. Potter with Amy Sands, Leonard S. Spector and Fred L. Wehling, Center for Nonproliferation Studies, 2004, ISBN 1-885350-09-0.

It's noteworthy that, when asked "What is the gravest threat to American security," both major candidates for president in the 2004 election gave the same answer: "nuclear terrorism" (San Francisco

Chronicle, 28 Oct. 2004). This book catalogues the growing nuclear threat.

This is a well-researched, sobering, flawed and ultimately disturbing look at the possibility of a nuclear terror attack at the heart of a major city in the near future. This reader views this book as an invaluable guide to the current international efforts to secure fissile material by physical security improvements, by regulatory initiatives, and by treaty provisions, but believes the book's suggestions to escape the danger are incomplete.

The "four faces" of potential nuclear terrorism are: the acquisition and detonation of an existing nuclear weapon, the building of such a weapon by a terrorist group, an attack on a nuclear facility (e.g. a nuclear reactor), and the dispersal of radioactive material by a conventional explosive (e.g. "dirty" bomb). The book presents a chain of causation for each potential terrorist act which provides readers with the necessary context to judge the threat, along with presenting opportunities to disrupt a nuclear terrorist action.

The book is at its strongest when presenting the facts on the potential for nuclear terrorism. The numerous tables of statistical and other information are well-designed and informative. The most important table presents the current worldwide stocks of fissile material. Worldwide, there are about 2,100 metric tons of both highly enriched uranium and plutonium. Given that only 50 kg of highly enriched uranium (HEU) or 10 kg of plutonium are needed to build a 10 kT device, there is enough fissile material worldwide to build 40-50 thousand weapons.

Additionally, as the authors suggest, we can take no solace in the idea that a terrorist group would need to test a device to prove its design prior to use. If a terrorist group uses HEU, a simple gun barrel design would suffice. The South African government held full confidence in their HEU weapon prior to their unilateral disarmament in the 1990s, although they may never have carried out a test. Their bomb was assembled in a warehouse that escaped detection over the many years when it was used as a nuclear weapon factory (p. 137).

In contrast with HEU, the spontaneous fission rate of plutonium precludes its use in a gun barrel design. A nuclear weapon constructed from plutonium requires an explosive lens to uniformly compress the fissile material, and would probably require testing. A terrorist group might not find this a difficult barrier to overcome. Forty years ago, two new physics PhD's developed a credible implosion design based on open literature; and in 1977 a Princeton undergraduate developed a credible plutonium bomb design for a term paper.

While the detonation of a nuclear weapon by a terrorist group would be a horrific event, an attack on a nuclear facility, or the detonation of a "dirty" bomb needs to be guarded against. The chapters dealing with these two possibilities are the most compelling. The authors detail current security problems at nuclear reactors and other nuclear facilities, along with current regulatory reform designed to address the very real problem of spreading radioactive material via a conventional explosive. These sorts of attacks will very likely be an effective terror mechanism, though clearly not as catastrophic as the detonation of a nuclear device.

The book's conclusions remarkably mirror those of the recent *Nuclear Terrorism, The Ultimate Preventable Catastrophe* by Graham Allison. Both books advocate controlling all nuclear weapons and all fissile material worldwide. However, Allison's book is far clearer in its prescription for the world. On p. 141, Allison states his unambiguous prescription: no loose nukes; no new nascent nukes; and no new nuclear weapon states.

There are some significant problems with the book. The book is filled with an alphabet soup of acronyms. While many terms are well known, some are obscure. For example, the book without prior definition uses the term NIS to mean Newly Independent States of the former Soviet Union. A minor correction would simply be to provide a glossary of terms. An editing shortcoming is the repetitive nature of many of the book's points. While repetition has its place in accenting certain ideas, the book makes too many references to the problems with the Russian nuclear security apparatus, as well as the uncertain political trajectory of Pakistan.

Moreover, this book comes up short in providing a roadmap for addressing the nuclear threat. The word "terrorist" or "terrorism" appears in nearly every sentence of the first few chapters. Yet, the book manages to avoid defining the term. Molly Ivin's column (reprinted in *San Francisco Chronicle* 16 Sep. 2004) puts the problem squarely: "defining terrorist ... as an absolute irrational evil gives us a spurious and intoxicating sense of self-righteousness, thus missing any chance to consider if correcting or changing our own conduct would be effective." The irony of "one goal common to all terrorism–causing psychological reaction within the target community" is that the statement applies to states and not just what we consider a terrorist group (p. 27). One might ask the authors what were the 'shock and awe' campaign of the Iraq war, the German Blitz, and the ensuing bombing campaigns of the United States and Britain in WWII, other than sowing terror in the target community? U.S. policy makers will find their efforts incomplete unless we look at our actions through the same lens as do our potential adversaries. For instance, Rear Admiral Jack Shanahan (Ret) argues that unless the United States curtails its efforts to develop a ballistic missile defense system, there will be little progress on issues of nuclear proliferation (*Topeka Capital Journal*, 18 Nov. 2004; on the web at *www.cdi.org*).

As a scientist, I cannot dismiss the possibility that any particular person with an agenda could engage in nuclear terrorism. However, I find it disturbing that the book lumps together "Animal liberation activists, anti-abortion advocates, pro-environmentalists, and even the anti-nuclear movement" with al Qaeda. Though the book does not consider these groups as dangerous as al Qaeda, the authors seem to believe any group that doesn't share the interests of the current power elite in the U.S is subject to suspicion.

In conclusion, the book states that there are very few terrorist organizations worldwide that can acquire or build a nuclear weapon and detonate it "in the United States." The book missed, perhaps purposely, the opportunity to acknowledge that the detonation of a nuclear explosive in any major city worldwide would be a catastrophe not limited to the United States. Like its conclusion, the book is an opportunity missed to broaden the debate on nuclear terrorism.

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Collapse–How Societies Choose to Fail or Succeed

By Jarid Diamond: Viking, 2005:560 pages,$29.95; ISBN 9-670-03337-5

Jared Diamond is a professor of Geography at the University of California, Los Angeles. He began his scientific career in physiology and expanded into evolutionary biology and biogeography. He writes "For the first time in history, we face the risk of a *global* decline. But

we also are the first to enjoy the opportunity of learning quickly from developments in societies anywhere in the world today, and from what has unfolded in societies at any time in the past. That is why I wrote this book". His motivation is praiseworthy and the resulting publication is superb. What he says touches on many disciplines making this book of universal interest. For example:

This is a book for environmentalists *and* for big business managers! The author has ornithological research as part of his background, but he insists that he is interested in environmental issues because of their consequences for people rather than their consequences for birds. On the other hand he has had much experience, interest and ongoing involvement with big business that exploits environmental resources and is often viewed as anti-environmentalist. His view is that if environmentalists aren't willing to engage with big business, which are among the most powerful forces in the modern world, it won't be possible to solve the world's environmental problems. On the other hand one of the most optimistic signs is that several big businesses are getting the message that they can best serve the their stockholders in the long run, by carefully including environmental concerns in their planning operations thereby producing sustainable resources, retaining public support and avoiding devastating clean up costs.

This is a book for the public. Diamond believes that in the long run it is the public, directly or through its politicians, that has the power to make destructive environmental policies unprofitable. Changes in public attitude will be essential for changes in businesses' environmental practice. As a corollary, this is a book for politicians who are encouraged to take bold courageous steps in long term planning..

Here is the pattern of the book. Part 1 is an analysis of Montana, a first world society with environmental and population problems that are real, and for which facts and societal relations are essentially clear. This sets a perspective for what happened in remote past societies. Part 2 is an analysis of societies that did collapse: Easter Island, Pitcairn and Henderson Islands, Native American Anasazi, Maya, and Norse Greenland. This is followed by societies which succeeded: Iceland, Tikopia, New Guinea Highlands, and Japan of the Tokugawa era. In Part 3 Diamond returns to what is happening in the modern world including Rwanda, the Dominican Republic, Haiti, China, and Australia. Finally with the knowledge of the past, Part 5 is concerned with practical lessons for today.

The method of study is quite different from that of the more exact experimental sciences. Diamond compares many different societies that differ with respect to "input" and "output" variables. The input variables are many. To make the analysis tractable he chooses the four factors; environmental damage, climate change, hostile neighbors and friendly trade partners. These factors may or may not prove significant for a particular society, but a fifth factor, the societies' response to its problems, is always significant. The "output" variables examined in this book are collapse and survival. By relating output to input variables, the author aims to tease out the influence of input variables on success or collapse. The environmental factor covers a large range of problems. For example, for Montana they include toxic wastes, logging and burning of forests, nitrogen exhaustion and soil erosion, the over-allocation of water, air quality, and the introduction of harmful non-native species.

Here is a glimpse of some of the factors that arise for specific societies. The population of Easter Island at its peak was ~15,000. In 1872 it was 111. The decay was associated with most of the above factors. For example pollen counts indicate that the islands were covered with forest including giant palms up to 7 feet in diameter, and yet, when the Dutch explorer Jacob Roggeveen visited the island in 1722, there was not a single tree over 10 feet tall. The deforestation of the island was a vital factor in the subsequent decay. Diamond poses the question: What did the Easter Islander who cut down the last tree say while he was doing it? Were the answers parallel to what we hear today:"Jobs, not trees!" or, "Technology will solve our problems; we will find a substitute for wood!" or, "There is probably more forest to be discovered; concern is premature and driven by fear mongering!" This is the subject of study in part 5. Of course there were many other problems, such as hostile neighbors, leading to the collapse.

In contrast, the tiny, isolated Pacific island of Tikopia has an area of 1.8 square miles, and has sustained a population of 1200 people for almost 3000 years. Working in favor of the Tikopeans was a high rain fall, moderate latitude, and location in a zone of high volcanic dust fallout which contained nutrients essential for the maintenance of soil fertility. The remainder of their good fortune must be credited to what they did for themselves through the bottom –up nature of their society in which every resident was familiar with the whole island, and was aware of the necessity to maintain a sustainable food supply and to prevent their population from increasing to an unsustainable degree. One of their delicacies and sources of protein came from the husbandry of pigs. A momentous decision taken consciously was the killing of every pig on the island because they recognized that pigs raided and rooted up gardens, competed with humans for food, and were an inefficient means of feeding humans. The Ticopians saw the problem, sacrificed a great delicacy and subsequently maintained their self supporting and sustainable life style.

Dr. Diamond succeeds in making the detailed story of these countries fascinating, almost like reading a detective novel as the various factors are disentangled. The fascination carries over to section five on the practical lessons for today.

The author recognizes the seriousness of the problems facing us. "If we don't make a determined effort, and if we do not succeed, the world as a whole within the next few decades will face a declining standard of living or perhaps something worse." After a gloomy analysis, it comes as a surprise when Dr. Diamond announces that he is a cautious optimist! One basis for hope comes from the realization that we are the cause of our environmental problems, and therefore we can, or cannot, choose to stop causing them and start solving them. We 'just' need the political will to apply solutions readily available. It depends on having the courage to practice long-term thinking and to make bold courageous, anticipatory decisions at a time when problems become perceptible, but before they reach crisis proportions. This contrasts with the short-term reactive decision making that too often characterizes our elected politicians. The Tikopeans did make those bold anticipatory decisions. The Easter Island community did not.

Another basis of hope is that the modern world's interconnectedness gives us the opportunity of learning quickly from developments elsewhere in the world today and from what has unfolded in societies at any time in the past. Along with this is the increasing diffusion of environmental thinking among the public around the world. This book is a great catalyst in this process, which is so necessary if public opinion is going to have the right effect. It has my highest recommendation.

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