PHYSICS & SOCIETY

IN THE APRIL 2003 ISSUE

EDITOR'S COMMENTS

It is very gratifying to see that a number of the issues which have been raised in this Journal in the past still continue to draw interest and comment from our readers. Equally pleasurable is the knowledge that our readership extends far beyond the borders of the U.S. The relationship between science and religion is one of these issues. The Commentary on the subject in January drew three objecting letters, which I have included here. Another of our continuing interests is the subject matter of the current play "Copenhagen". This issue presents a view, from Germany, of the topic contrary to those we have published previously. Our discussion of the civil aspects of nuclear power continues with two letters and an article whereas a review and commentary look at nuclear power's military aspects: "the bomb."

A new subject for us is science education. This issue contains two articles on the subject - one with cartoons!

Finally, we are happy to announce that our Journal now has a news Editor, Jeff Marque, who has also agreed to serve as general co-editor, thus broadening the vision we can present to you.

A.M.S.

ELECTION RESULTS

The results of the 2003 FPS election are in. We had, as usual, an extremely strong group of candidates. The winners of this year's election are:

- Chair-Elect: Mark Sakitt
- Vice-Chair: Tina Kaarsberg
- Executive Committee: Barry Berman and Susan Ginsberg

As you recall, there were two Chair positions in this year's election. The reason was that Michael Rosenthal resigned his position of Vice-Chair since he accepted a position at the International Atomic Energy Agency in Vienna. Tina Kaarsberg's election to Vice-Chair creates a new vacancy on the Executive Committee because she was elected a member of the Committee in 2002. Thus, an offer was made to Charles Ferguson, who finished third in the election for Executive Committee and we are thrilled that he has graciously agreed to join us effective immediately.

We received a grand total of 479 votes (from a total membership of 4549) of which 36 were paper ballots. Many thanks to everyone who ran this year and to Marc Sher who ran the electronic portion of the election.

Andrew Post Zwicker,
Secretary/Treasurer

ARTICLES

THE TROUBLED STATE OF U.S. SCIENCE EDUCATION: PROBLEMS AND POSSIBLE SOLUTIONS

Daphne Burleson

How is it that the United States is considered to be the world's leader in technological innovation including science research and development; yet in terms of science and mathematics testing, our 12th grade students scored near the bottom compared with students from other countries.[1]

According to the Third International Mathematics and Science Study (TIMSS), U.S. 12th grade students not only scored near the bottom on recent tests, but specifically scored behind every other nation, except Cyprus and South Africa.[2]

Furthermore, in physics, the United States scored at the very bottom as well.

On December 2001, during a House Floor discussion on funding for science education in the FY 2002 budget, Representative Vernon Ehlers (R-MI) acknowledged that the United States is indeed "dead last among those nations in high school physics." Interestingly enough, Representative Ehlers is one of only two physicists serving in Congress since 1996. He further went on to refer to the 2000 NAEP (National Assessment of Education Progress) results which found no improvement in science literacy in the 4th and 8th grades, and a decline in science performance in science performance in grade 12 since 1996.

Yet conferees on the FY2002 Labor-HHS-Education appropriations bill (H.F. 3061) provided substantially less targeted funding than in 2001 for improving science and math education. In the resulting conference report, however, states were encouraged to continue their current level of effort to improve science and math instruction by making use of funds available for improving overall teacher quality.

Is simply improving overall teacher quality the answer to the continuing troubled state of U.S. science education – or, are there and should there be other methods in addition?

On January 15, 2001, a study by Professor J. Hubisz, President of the American Association of Physics Teachers, published by the Associated Press, showed 85% of middle school students are using science textbooks so full of errors and inaccuracies as to make them unacceptable. These books have been called "terrible"[3] from a science standpoint, and it has been stated that many science teachers have little science training.

According to a recent Bayer survey, 'The Bayer Facts of Science Education VI: Americans' Views on Science, Technology, Education and the Future', 93% of respondents said students in their state need a stronger education in science to be prepared for the new inventions, discoveries and technologies that increased investment will likely bring. They also stated a belief that the way to strengthen science education is for their state and governor to support pre-college science education reforms that emphasize inquiry-based, hands-on learning over traditional textbook and rote memorization.[4]

I believe strongly that hands-on learning is the best, most practical way of learning in science education; when you consider the high school requirements of 3 years of science and math, the importance of truly immersing students in these subjects comes to the fold. A critical step in achieving strong, positive results, is to expose students to the hands-on approach.

Nobel Laureate in Physics, Leon Lederman, has stated that "Science works in a hierarchy. It's a pyramid with mathematics at the base. Physics requires mathematics and is second." So in a sense, the two go hand and hand and should be considered critical in learning.

In his paper, "Scientists and Science Education Reform: Myths, Methods, and Madness," James Bower, Associate Professor of Biology at California Institute of Technology, states his own findings from studies of California schools. He theorizes that "attempts to transfer the excitement of science through lectures never gives teachers the opportunity to experience the thrill of doing science themselves." He sites that in most cases, "the 'hands-on' activities are do-it-yourself 'cookbook' demonstrations of the sort professors design for their own undergraduates."

Having taken more than a science course or two, particularly physics, in my lifetime, I have seen this in practice. Even in high school, the teacher would perform the experiment in lecture to ensure the same outcome each and every time. Often student reaction would flicker from slight interest into complete boredom in watching the teacher demonstrations. Although I do remember once, my biology teacher elicited quite a "shock-jock" response when he one day produced a fetus-in-a-bottle from a pocket in his lab coat merely for the "fun" of it.

My question is: Why should science experiments solely be performed by teachers in lectures? Why can't time be specifically allotted for students to participate in science activities and experiments themselves in addition to being introduced to the subject at hand by their teachers?

And what of the claim that science teachers are inadequately prepared to teach science?

In his report on science education, Bower states his finding that "the more college science courses a teacher has taken, the more likely they are to model their teaching on the lecture-based approach of most university science professors." He also states a finding that "teachers with fewer college lecture-based science courses are often more amenable to fundamental change to inquiry teaching methods than are those whose examples for science teaching come from college and university professors", and "as these teachers become involved in real science experiments in their classrooms, they inevitably seek additional science content knowledge.[5] This would seem to strongly sell the argument that teachers with fewer lecture-based science courses are more open and willing to use hands-on teaching methods in their courses. With this in mind, it is important to continue to establish the importance of having real experimental science and inquiry-based learning in our schools.

Science involves inquiry and exploration. Its teaching should allow opportunities for real open-ended scientific discovery. I believe that splitting lecture time into in-class hands-on lab time in pre-college education courses is the best way. Another key is in relating the teaching of scientific principles to what's going on in the real world.

Students can be encouraged to read the newspaper on a regular basis, specifically looking for science articles discussing what's happening around them. These articles can be brought into class and shared with fellow students in discussions lead by teachers, further supporting the inquiry-based learning process.

Sooner or later, the deficiencies in U.S. science education will catch up with our advances in scientific and technological development. A new philosophy of true hands-on learning on the part of students in cooperation with their teachers seems the most practical solution.

Notes

1. IEEE*USA/Bayer, July 2000
2. Grandfather Education Report, February 2002
3. Grandfather Education Report, February 2002.

Bayer Corporation, July 2002.

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Physics on the Subway

Robert H. Romer

If you ride the buses serving the "Five-College" community here in western Massachusetts, on each bus you will find one or two "physics ads" in addition to the usual "Please don't eat on the bus" placards. In each one, a number of articulate cats and dogs get into a brief physics discussion, ending with "Let's Try It!" and "What Do You Think? Visit Our Website: www.amherst.edu/~physicsqanda ". Our initial questions include physics professor favorites such as "Which way does the tricycle go? " and "The helium balloon in a car" and questions of enduring interest to the public such as "Should I turn down the thermostat at night"? (That one seems obvious to *us*; to most ordinary people - i.e., nonphysicists - it is not obvious at all.) One of our placards, reproduced below, is an old physics puzzler, "Throwing the anchor overboard". I am now a member of what may be a very select group - those who have done the experiment; no matter how solid the theory, I was not going to go public without the experimental test.

We want to give bus riders (and web surfers) the idea that thinking - even (or especially) about physics, with its bad reputation - can be fun. Physics deals not only with galaxies and quarks but also with everyday objects and phenomena. Don't stop with our handful of questions - keep your eyes and minds open to the natural world around you.

Although this project is so far "Physics on the Bus" (and our *local* buses at that), we call it "Physics on the Subway (POTS)" to indicate our higher ambitions (for which we will need money beyond that provided so far by Amherst College and by our own pockets). POTS is a small part of a dream that John King and I call "Physics Everywhere" starting in the cradle with an "Age-Zero Physics Kit" for every newborn child. (See King's Oersted Medal talk "Observation, experiment, and the future of physics", *Am. J. Phys.* 69 (1), 11-25 (2001) for a full description.) The idea of putting placards on buses and subways is one that we were pleased to borrow from physicists in the U.K. who have done something similar on the London Underground. (Brenda Keogh, Stuart Naylor, and Catherine Wilson, "Concept Cartoons: A new perspective on physics education", *Phys. Educ.* 33 (4), 219-224 (1998).) Our drawings are by our talented artist and collaborator, Bruce Aller. (See cartoons below and in next file.)

The website has received a great many emails (and I feel guilty about not having answered all of them yet). Some are just nice: "It's wonderful to have found something entertaining AND intelligent on the internet for a change. I look forward to more Qs&As. Keep up the good work! " Some argue with our answers: "You're wrong! The trike goes backward. I haven't tried it, but I don't need to. Too bad you made a mistake. Interesting, anyhow. " Many have suggested more questions for us or simply asked us to respond to theirs: "This is a little morbid, I admit, but it's something I have wondered about for years. If you are in an elevator that is falling, will jumping up and down reduce your chance of being killed when it hits - assuming, of course, that you are in mid-air when the elevator hits bottom. Thanks!"

We would welcome your comments, suggestions for further questions, and especially for thoughts about other transit systems that might be as cooperative in this project as UMass Transit has been.

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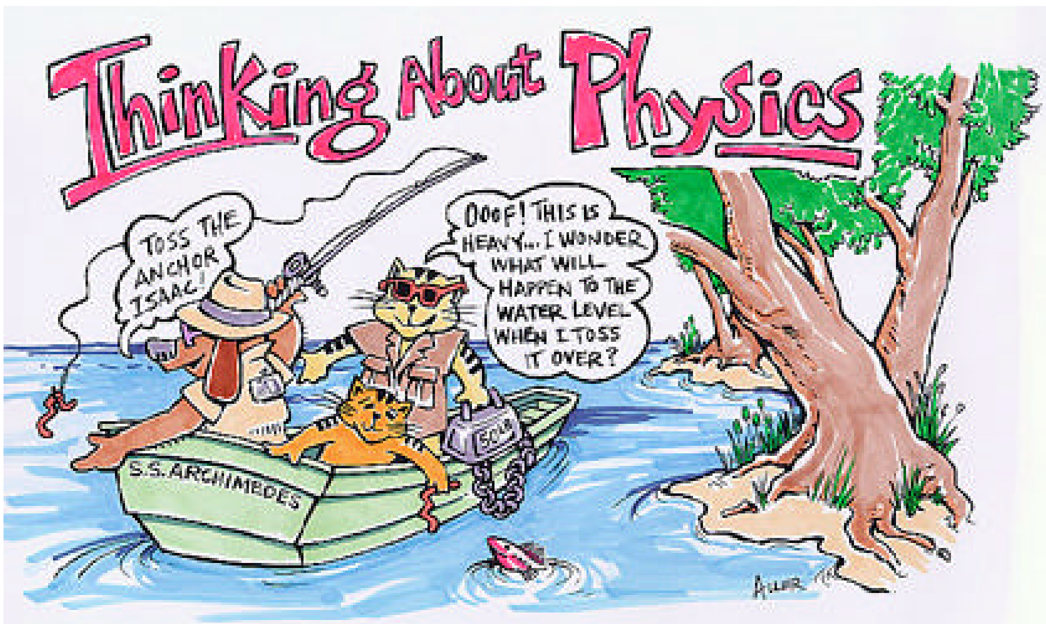


MAYBE THOSE TWO THINGS CANCEL EACH OTHER OUT?
LET'S TRY IT!
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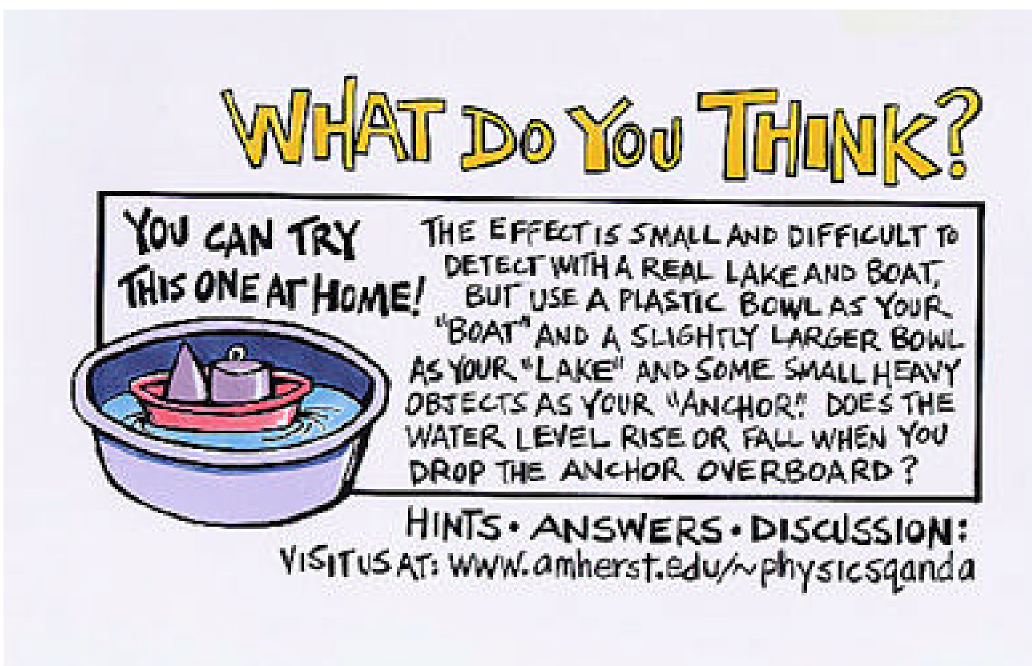
ADMIRAL ALBERT


WHAT DO YOU THINK?
YOU CAN TRY THIS ONE AT HOME!
THE EFFECT IS SMALL AND DIFFICULT TO DETECT WITH A REAL LAKE AND BOAT, BUT USE A PLASTIC BOWL AS YOUR "BOAT" AND A SLIGHTLY LARGER BOWL AS YOUR "LAKE" AND SOME SMALL HEAVY OBJECTS AS YOUR "ANCHOR." DOES THE WATER LEVEL RISE OR FALL WHEN YOU DROP THE ANCHOR OVERBOARD?
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Securing the Atom – Using Advanced Simulation to Look Ahead to 21st Century Nuclear Energy

Edward D. Arthur

Nuclear energy could grow rapidly in the coming decades, driven by two major factors – - expanding energy demand occurring in developing nations and requirements for emission-free energy production derived from regional or global environmental needs.

Historical data indicate that energy use is linked to prosperity. Typically a nation has reached a "developed" state when its per capita annual electricity use is several thousand kilowatts[1]. In the future an increasing number of nations could meet "prosperity" conditions and simultaneously have significant populations. In the developing world, in addition to China and India, nations such as Brazil, the Philippines, Indonesia, Mexico, Turkey, Thailand, Iran, Columbia (among others) could reside in the top-twenty most populous nations and could achieve energy usage characteristic of developed nations by mid century [2].

Under such scenarios, nuclear energy, nuclear materials and nuclear materials technology could exist in environments very different from that of the past forty years. At issue are what types of nuclear technologies could lead to achieve even higher levels of proliferation resistance, safety, economics, and environmental performance required in the future? What are technology routes and tools that could help create needed nuclear energy and fuel cycle systems optimized for 21st Century needs and implementation?

Meeting requirements of the types indicated above place strains on the nuclear energy infrastructure present in the United States and other developed nations. Nuclear facilities (laboratories, nuclear materials processing, test reactors, and critical assemblies) are often old, in a state of decline, and a significant number have ceased operation. Student populations in areas associated with nuclear energy (nuclear engineering and physics, materials science, actinide chemistry,…) are also decreasing.

At the same time, capabilities in advanced simulation and massive computational power have grown substantially. Nuclear weapons stockpile certification, a technology area having major parallels to the nuclear energy area, has adopted massive simulation (through the Advanced Simulation and Computing Initiative (ASCI)) as a means of meeting its needs in the absence of nuclear testing. The simulation philosophy of the ASCI program is to incorporate detailed models of processes and systems on a multidimensional scale (microscopic, macroscopic, to full systems levels) that are then run on large, massively parallel computers. A similar approach could be developed and employed for nuclear energy system design and nuclear materials control. Two example areas are presented.

Enhanced integration and optimization of proliferation resistance and safeguardability into fuel cycle facilities and operations

Future nuclear energy demand scenarios could lead to larger-scale and more widespread implementation of closed fuel cycles (ones where spent reactor fuel is reprocessed to recover plutonium and higher actinides which are further consumed in reactors). For the first half of the 21st Century, thermal reactors (light water, heavy water, or gas-cooled) will probably represent the mainstay for nuclear energy production. At the same time, recovery of plutonium and higher actinides, as well as certain long-lived fission products, followed by their burning or transmutation, could see widespread implementation as a means to reduce the number of geologic repositories required for a once-through nuclear fuel cycle (as presently implemented in the United States). In closed cycle systems, inherent proliferation resistance and safeguardability attributes protect against nuclear materials theft, materials diversion, and/or national efforts to acquire materials from civilian nuclear energy facilities and/or technology.

The past development and construction of nuclear materials facilities have often approached safeguardability as an "add on" -- *ie* detection and material control systems are implemented once a design has been largely developed. Two simulation-based approaches can be used to integrate and optimize, in an *a priori* fashion, facility operations and safeguards. The first is detailed facility simulation models that include features describing

- The tracking of materials (plutonium, uranium, …) inventories through all processes;
- microscopic materials separations flowsheets;
- all relevant process operations including equipment performance description, material inventories, and transfer lines; and
- measuring instruments performance and expected data; and
- a wide variety of process logic options.

Earlier [3] versions of such nuclear material facility simulators have been used to assess the performance of facilities such as the Rokkasho reprocessing plant under construction in Japan. Newer approaches, based upon dynamic systems simulation, that utilize commercially available platforms such as EXTEND^{TM}, offer the potential for expanded capabilities and flexibility.

A second promising method lies in the utilization of multimillion-dollar gaming industry engines to create true-to-scale interactive, virtual environments. Such approaches (for example the Virtual Interaction Simulation and Inspection Tool (VISIT)[4]) allow development of three-dimensional interactive architectural and outside-world representations that can be true to scale and operation. These methods can provide visual details and simulated processes for replication of real physical locations (equipment, facilities, buildings) and environments, and can allow multiple users to interact in the same virtual environment.

The development and use of such tools could provide increased confidence in the operability and safeguardability of future nuclear material facilities by exploring computationally the effects of alternative processing methods on the operating characteristics of a proposed facility, by computationally evaluating nuclear material inventories and associated detection systems, and by allowing evaluation of "what if" scenarios to maximize resistance of facilities to materials diversion and misuse.

Advanced Simulation - The Numerical Reactor

Future implementation scenarios for nuclear energy will place increased emphasis on the operational performance of nuclear reactors and associated systems. Safety will be continue to be of paramount importance as the number of reactor operating years increases worldwide. Traditional reactor safety requirements may have to extend well beyond traditional limits to include situations where deliberate actions (terrorist, insider threat) could maximize negative impacts normally associated with a severe reactor accident. Today a number of uncertainties exist pertaining to the description and assessment of severe reactor accidents. They include the interaction of fission products with the reactor vessel and containment, core melting and subsequent interaction between a molten core and concrete, containment response and failure modes, and, overall, the validation of diverse computer codes used to model complex sequences of events.

Advanced simulation, coupled with modern computational power, could provide powerful tools to further enhance the robustness of future reactor systems. For example, reactor safety codes were largely written in the 1970's when supercomputers were one-thousand times slower and had roughly one-thousands of the memory of today's supercomputers. Such computers (and codes) use approximation algorithms to solve necessary partial differential equations for representation of two-phase flow. These approximations create numerical errors, violate energy conservation, etc. Modern computers and numerical methods can allow simultaneous, and accurate, solution of non-linear, coupled sets of partial differential equations describing two-phase flow with conservation of mass, momentum, and energy in both phases.

In analogy with the ASCI example mentioned earlier, a virtual or numerical reactor simulation system could be created having the following features:

- the description in three dimensions (plus time-dependent behavior) of microscopic processes involving particle transport, materials response, chemical kinetics, and time-dependent nuclear data;
- meso and macroscopic descriptions of thermal hydraulics, radiation damage, fuel performance and burn, subsystems including heat exchangers, safety and control, and power conversion as well as system interfaces and feedback processes;
- systems levels descriptions including containment structure performance and creation of "virtual" assessment environments.

"Models" currently exist that point to the end product for such a simulation system (or for key components). One example is the MCNP Monte Carlo particle transport code[5] that operates within state-of-the-art parallel computing environments and allows computation of transport phenomena within sophisticated geometrical environments. Another recent, and very pertinent model for a numerical reactor simulation system is the multinational REVE (Reactor Virtual Experiment)[6] effort. This project aims at quantitative simulation of irradiation effects in materials, thus complementing and eventually replacing presently-used empirical approaches. An eventual computational system, benchmarked with suitable experimental data, could reliably move simulation from interpolation between known data to prediction into performance areas lacking in experimental data.

These two examples illustrate the power and potential of advanced computing and simulation as applied to advanced systems for nuclear energy and nuclear materials control. Developing and applying results of such systems could engage and attract new talent into an important national and international need area. Equally important, such capabilities could be a cornerstone for the development of safe, secure, and cost-effective nuclear energy systems needed for the 21st Century.

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[2] E. J. Moniz, personal communication, November, 2002.

[3] T. Burr; L. Wangen, A.Coulter, "Simulation and Analysis of Plutonium Reprocessing Plant Data", Proceedings of the 37th Annual meeting of the Institute of Nuclear Materials Management (Naples, Florida June 1996), Los Alamos National Laboratory informal report, LA-UR-96-2614, June 1996.

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Thoughts on Edward Teller's memoirs

(Edward Teller, *Memoirs: A Twentieth-Century Journey in Science and Politics*, Perseus Publishing, Cambridge, MA (2001), 628 pp.)

Donald H. McNeill

Edward Teller's *Memoirs* (published in his 93rd year) discuss science, politics, and his personal life, especially his devotion to family and his exiles-- from Hungary in the 1920's because of the *numerus clausus* in Hungarian universities, from Germany in the 1930's because of Hitler's rise to power, and from the American physics community because of his testimony against Oppenheimer. These memoirs are a distinctive, important record of the twentieth century, but they do not provide an accurate history. This is a book to react to, as well as to read.

In his long life, Edward Teller has participated in most of the major physics events of the twentieth century. As a student and young graduate, he contributed to the glorious days after WW I in Germany and Denmark. He helped arrange Einstein's letter of August 1939 to Roosevelt that initiated the US atomic bomb project and he worked at Los Alamos during the war. The latter sixty percent of his memoirs is devoted primarily to political themes, including the development of the H-bomb, establishment of a second nuclear weapons laboratory, and the Oppenheimer hearing, as well as work against nuclear test bans and arms control and for ballistic missile defense and peaceful uses of nuclear explosives.

As a physicist born shortly after WW II, I have heard of Edward Teller all my life. In my own work, I have come across some of his scientific collaborations, including the BET theory, Inglis-Teller effect, and Jahn-Teller effect. In politics, his contributions have been individual and forceful. Having read several of his books, I already "know" him, but his memoirs are the longest and most readable of the lot.

Teller devotes an astonishing amount of space to J. Robert Oppenheimer, about whom almost everything is "suspect," from the time of their first meeting in 1942 until Oppenheimer's death. Teller was already a focus of controversy before his negative testimony at the hearing (April-May 1954) which led to the removal of Oppenheimer's security clearance. Teller's extended discussion confirms that the Oppenheimer hearing is the central point in his own life and that he is still much vexed over his rejection by many American physicists following his testimony.

The famous Teller-Oppenheimer dichotomy is not, in fact, well defined in terms of history or morality. Teller and Oppenheimer are not the "opposites" of myth. Teller is a brilliant man of considerable integrity with some unpleasant, dangerous opinions regarding armaments. He is also a nasty manipulator. Oppenheimer shares some of these characteristics in the guise of a very different personality. Oppenheimer did a magnificent job for our country in the Manhattan Project and it is sad to contemplate how the government treated him afterward. Teller argues in his memoirs that the reason he spoke against granting a security clearance to Oppenheimer was the latter's treatment of Haakon Chevalier. This claim is inconsistent with Teller's story as it evolves in these memoirs. Oppenheimer was dropped because of insufficient enthusiasm for the H-bomb [395]. (References to pages in *Memoirs* are given in brackets.) That was the government's policy interest, and Teller was a handy tool for the occasion.

Teller has a point about Oppenheimer's treatment of Chevalier. I read about the Oppenheimer affair when I was in high school, and felt that Oppenheimer mistreated Chevalier and was not a nice guy. Indeed, Oppenheimer left a number of his graduate students and colleagues to blow in the winds of the anticommunist hysteria of the 1950's. David Bohm, one of Oppenheimer's students and among the brightest US-born physicists of the century, had to develop his career overseas. When my wife read Robert Jungk's *Brighter than a Thousand Suns*, a history of the atomic bomb published in the 1950's, she also got a bad sense of Oppenheimer, despite Jungk's sympathy for him. As she said, that is a sign of a well told story. So, Oppie was not a good friend. And he told some fibs to the security people in the Manhattan Project, all of which they knew about.[1] But that was not the issue for the Personnel Security Board. Teller's "distaste for ambiguity in friendship" is firmly stated [394], but in the Oppenheimer affair he was being used.

Teller's comments [395+] on Oppenheimer's hazy moral reasons against further work on the H-bomb are obliquely appropriate. Oppenheimer's occasional arguments for preventive war and further weapons development were not far from actual US policies or, as it appears today, from the consequences of Teller's positions. Preventive war is only a step away from the later policy of mutually assured destruction. If war happens, the distinction lies in the time of attack.

In the early postwar years, the nation's leadership was conceding the country's future to increasing militarization. Eisenhower commented on this trend in his farewell address in 1961, to Teller's scorn [459+]. Massive nuclear armament was advocated by, among others, Forrestal (the first Secretary of Defense, whose paranoia was well known), Baruch (who subverted the Acheson-Lilienthal proposals for international control of nuclear energy), Byrnes (secretary of state), Generals LeMay, Arnold, and others (who threatened to bomb Soviet cities in "massive retaliation," long before they could have attacked), and Dulles. The record presented by Teller shows that he was speaking for (but, I emphasize, not working for) E.O. Lawrence, Willard Libby, and Lewis Strauss, all of whom were strongly opposed to Oppenheimer. Teller was always a true believer, quite willing to "be alone." We can infer from his long list of politically agreeable friends that he was not really alone from 1945 onward. His efforts to vindicate himself vis-a-vis Oppenheimer, Rabi, and Bethe and to gain sympathy for himself in his isolation of half a century ago are unconvincing. I suspect that Teller could (have) ease(d) his pain over Oppenheimer by looking "outside" himself occasionally.

Teller has often spoken and written about the problem of secrecy, and he sometimes makes sense about it. But his own use of secrecy to cover his tracks or avoid the appearance of incompetence or failure is evident in his memoirs. This is analogous to the government's use of secrecy.

The successes of the plowshare program (nuclear explosives for excavation and enhanced gas production) were more limited[2] than Teller claims [448+, 466, 492+]. His praise of Soviet successes in this area compared to American failures is quaint nonsense. Both the Soviet and American programs were flops-- unnecessary and without economic benefit. Nobody uses "peaceful nuclear explosives" today or would even think of it; the demand did not come from the consumer.

Teller can be a lucid writer, but he does not explain the "secret" of the H-bomb clearly. His discussion of thermal disequilibrium and radiation opacity [178+, 312+] hints at, but skirts, the mechanism by which radiation from a fission explosion initiates a fusion explosion in the H-bomb, even though much of the idea has been exposed publicly since 1970 (laser fusion!).

Fallout from nuclear tests was the major reason for the atmospheric test ban of 1963. Teller's figurehead opposition to a test ban delayed this treaty for years. He still defends nuclear testing and opposes agreements limiting nuclear armaments. He writes [440] that "the annual amount of radiation received from atmospheric nuclear testing at its highest level (in 1963) was 13 mrem." This is presumably to be compared to the roughly 100 mrem annual dose at sea level from natural sources. Fallout, however, is not distributed uniformly over the earth's surface. Thus, cumulative doses exceeding 3.0 roentgens (for gamma rays, equal to 3000 mrem or more than 200 times Teller's value) were reported[3] for inhabited areas more than 80 miles from the center of the Nevada test site from about 1 MT cumulative fission explosion energy release through 1958.

Andrei Sakharov, the leading Soviet developer of the H-bomb, had a very different career and very different sensibilities from Teller's. Teller writes [320], "I formed the impression that the Russian physicist's strong negative feelings about nuclear explosives may have been related in part to the use of political prisoners as laborers at test sites, and the lack of even rudimentary safety measures to protect them. The situation in the United States was very different." Teller refers smugly [463] to Sakharov's "impression (based on well-publicized speculations) about the hazards of low-level radiation." On the contrary, Sakharov's views were strong and well founded:[4] "My view of nuclear tests in the atmosphere as a direct crime against humanity no different, say, from secretly pouring pathogenic microbes into a city aqueduct, a viewpoint which I came to hold even the 1950's, received no support among the people around me. I saw how easily people fit their opinions to conceptions that are convenient to them." Given his contributions to the Soviet civil rights movement from 1965 onward, Sakharov was undoubtedly aware of prisoners working in the weapons complex, a phenomenon widespread throughout Soviet society. Was the safety situation really different for the Indian uranium miners of northwestern New Mexico in the 1940-60's? Many of them died of radiation-induced lung disease long after the danger was identified.

Teller's "impressions" are a grotesque trivialization and distortion of Sakharov's own views on nuclear testing and armaments from 1959 to his death. Sakharov wrote,[5] "Three technical aspects of thermonuclear arms have made thermonuclear war a threat to the very existence of civilization. These are the enormous destructive power of thermonuclear explosions, the relative cheapness of rocket-borne thermonuclear weapons, and the practical impossibility of effective defense against a massive nuclear missile attack." Teller's faith in defense against nuclear weapons and missiles appears early, with reports he wrote for a naval officer in 1945 [218+] and for a member of Congress in 1946 [224+], continues through the Star Wars episodes of the 1980's [525+, 541+], and on to the present day. The impossibility of effective defense was pointed out in the Acheson-Lilienthal report[6] and has never been refuted by any of the missile defense notions upon which our country has spent billions of dollars. The Acheson-Lilienthal report treated nuclear weapons as a political problem with no long-term solution except the limits of (1) agreement to stop their production and deployment by all or (2) annihilation.

Teller cites E. U. Condon's "discomfort" with Oppenheimer as the reason for his resignation from the Manhattan Project in 1943 [180], but Condon, himself, wrote[1] that the main issue was "compartmentalization" (i.e., General Groves). Herbert York was the first director of the Livermore laboratory. After leaving that position (succeeded by Teller), York became an effective government advisor and negotiator for the test ban and later treaties. He provided the world with much information to counter the claims of the nuclear armorers.[7] Teller makes no mention of York's opinions and later activities, except to note that "the current *[in 1958]* director of the laboratory, Herb York, leaned considerably toward approval of such a treaty" (atmospheric test ban) [434].

Teller delights [531+] in his contribution to Reagan's "Star Wars" speech of 23 March 1983 (actually a brief appendage to a longer speech mainly about Cuba). A more representative incident that Teller fails to mention is the role of his "x-ray" laser missile defence scheme in the failure of the Reykjavik summit of October 1986, where Reagan met the Soviet leader Gorbachev to discuss disarmament. At that time there was a battle at Livermore regarding data from x-ray laser experiments, whose success had been trumpeted by Teller and the laboratory administration, while the immediate supervisors were concerned about the validity of that data. Briefed on the "successes," Reagan believed the system was nearly ready for deployment and pressed the Russians on the matter, thereby wrecking the Reykjavik talks. After long political battles and (as in the 1950's) damage to the careers of some opponents of the x-ray laser scheme at Teller's instigation, the results were shown to be negative, bordering on fraud.[8]

In sum, Teller's memoirs are an extensive record of physics in the twentieth century. His stories of his student and post graduate life are lively and engaging, as are his stories of his devotion to his wife and family. The book begins with several typographical errors in Hungarian and ends with a dubious interpretation of Aristarchos' name as "best beginning." ("Noble leader" is a better translation.) In between, there are so many distortions of history, science, and politics that the reader is well advised to check other sources. Teller has his "glasnost'" in these memoirs, but the rest of us need more data.

Over the years Teller seems never to have grasped the relationships among the interests and activities of those who do research (this pays well), those who build weapons (this pays even better), those who use weapons (mass murder presents problems to many military leaders), and peace (even bigger problems). He writes that "in a democracy, using nuclear weapons is an issue entirely different from that of working on their development" [396]. To the extent that this ambiguous notion is true here, it was true in the Soviet Union. (Khrushchev pointed it out to Sakharov[4,5] [464].) Leo Szilárd, who was central in starting the bomb project but left at war's end, had a clearer understanding: "brass hats are brass hats."

Teller laments that, "For more than four decades, well-qualified scientists whose contributions would have been of great value have tended to avoid weapons work. I suspect that at least part of that unwillingness arose because of their misunderstanding of the Oppenheimer hearing and of security regulations." [396] Actually, some of us have understood these things well. As the US sets out on a course of independent warmaking all over the globe in the early twenty first century, with the rejection of at least ten international agreements on armaments and the conduct of war in the first eighteen months of the George W. Bush administration, it is important to remember that for our country, the tragedy is that, through the influence of Teller and people like him, the US has pursued unlimited armament as the answer to our and the world's problems, while ignoring far less expensive and more durable diplomatic and cooperative initiatives. Teller has, from time to time, been aware of the limits of armaments [562+], but simplified technical solutions have more charm for him than for most other people. It looks like it's been a while (50 years?) since any of his proposals actually worked.

1. L. Groves, Now it Can be Told: The Story of the Manhattan Project, Harper, NY (1962).

2. B. Bolt, Nuclear Explosions and Earthquakes: The Parted Veil, W. H. Freeman, San Francisco (1976).

3. G. Dunning, “Fallout from nuclear tests at the Nevada test site,” in: Hearings before the Special Subcommittee on Radiation of the Joint Committee on Atomic Energy, Congress of the United States, 5-8 May 1959, Vol. 3, pp. 2021-2113.

4. A. Sakharov, Vospominaniya [Memoirs], Chekhov Publishing Corp, NY (1990). Sakharov's encounter with Teller is discussed in his companion memoir Gor’kii, Moskva, dalee vezde [Gorky, Moscow, and everywhere else], (1990).

5. A. Sakharov, Thoughts on Progress, Peaceful Coexistence, and Intellectual Freedom, June 1968 (in O Strane i Mire [About my Country and the World], Khronika Press, NY (1976), pp.139-179).

6. A Report on the International Control of Atomic Energy, US Dept. of State, 16 March 1946.

7. H. York, Making Weapons, Talking Peace: A Physicist’s Odyssey from Hiroshima to Geneva, Basic Books, NY (1987).

8. W. Broad, Teller’s War: The Top-secret Story behind the Star Wars Deception, Simon and Schuster, NY (1992).

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Why Did Heisenberg go to Copenhagen?

Klaus Gottstein

The following "article "is taken from a letter sent to J.J Solomon in response to his article in the October, 2002 issue of Physics and Society*. It should be very interesting to those who have been following the controversy - in this journal and elsewhere - about the play* Copenhagen.

... I suppose that in the meantime you will also have read my letter to APS News which was enclosed with my letter of 16 December. It was published in the February 2003 issue of that journal. In it I mentioned the remarkable fact that only two days after Heisenberg's famous, misunderstood conversation with Bohr in 1941 on the feasibility of atomic bombs, Heisenberg spent a very harmonious evening with Bohr in his home where they discussed physics, avoiding politics, Heisenberg played the piano and Bohr read a story to him. (This information was discovered recently in an hitherto unpublished letter written by Heisenberg to his wife while still in Copenhagen in 1941, and posted right after his return to Germany, probably in order to avoid censorship.) This indicates that Bohr, although upset by what he thought Heisenberg had been trying to tell him two days before, was not really angry at Heisenberg personally even though, as Bohr put it later in his unsent letters, they now belonged to two sides in mortal combat with each other. This lack of anger is also shown by the friendly tone of the "Bohr letters" in spite of Bohr's objection to what he had read in Robert Jungk's book, (wrongly) assuming that Heisenberg had agreed with everything that Jungk had written. Also Bohr's behavior towards Heisenberg after the war, the mutual visits of the Bohr and Heisenberg families in their homes, and their joint vacations in Greece or Southern Italy after the war, seem to confirm this.

But let me start with my comments to your article "Copenhagen in Europe: Why not the same debate as in the US?" They may come too late to be taken into account in its publication, but I mention them anyway. Your article is very serious and deserves serious comments.

On page 2 you say that Heisenberg's visit remains a mystery. I do not think that there is a mystery. It is rather clear from what Heisenberg and Weizsäcker said and wrote credibly about this visit that it was motivated by a mixture of considerations. By September of 1941 Heisenberg and Weizsäcker had understood that atomic bombs were technically feasible in principle, but in reality extremely difficult to make, by isotope separation as well as by producing in a reactor what was later called Plutonium. It would take years and could therefore not be completed while the war lasted. Nevertheless, in the long run the technical possibility of making atomic bombs existed. The technical capabilities of the US (still neutral at that time) were much greater than those of Germany. Roosevelt was not friendly towards Nazi Germany. Would it be conceivable that US scientists would produce a bomb finally to be dropped on Germany? Was it justifiable anyway that the international community of atomic scientists, so far engaged in peaceful basic research, now worked on such a dreadful weapon? Was there a way to avoid this? Wasn't it lastly up to the small international group of scientists which Bohr had led in the past two decades to decide whether or not these ghastly weapons were built? After all, their cooperation would be needed.

Weizsäcker suggested to Heisenberg that they should consult Bohr about these difficult questions. Niels Bohr was the recognized father figure of the atomic and nuclear physics community, his wisdom and integrity were respected internationally. Moreover, Heisenberg who before the war had been in constant contact with his old friend and mentor Niels Bohr, had not seen him since the beginning of the war and was concerned about his well-being under German occupation. (Bohr acknowledges this motive in one of his unsent letters.) Of course, all these motivations would not have been sufficient for obtaining visa and travel clearance for a trip to occupied Denmark. But Weizsäcker, with the help of his father, was able to overcome these difficulties by having Heisenberg and himself invited to an astrophysics conference organized by the German Culture Institute in Copenhagen which was a propaganda outpost of the Cultural Division of the German Foreign Ministry in which Weizsäcker's father was the top civil servant (Staatssekretär). The rest of the story is rather well known although, as parts of the literature and also your article show, there are still many misunderstandings in the air. But if you go to the sources of information there is really no great mystery.

You think that there is a contradiction between Heisenberg's conjecture in September of 1941 that Germany might win the war, and Heisenberg's desire to get Bohr's opinion about potential steps by which the construction of atomic bombs could possibly be avoided. Why is that a contradiction? If Germany was about to win the war, wouldn't that be an even increased incentive for the Americans and British to try to make the bomb and use it against Germany, some time in the future? It seems to me that, independently of whether Heisenberg thought that Germany was going to win or going to lose the war, it is quite understandable that, facing all these troublesome questions, he sought the clandestine advice of his old friend.

Page 3: Rotblat did not leave the Manhattan Project after German defeat, as you write, but in 1944 when it became known to him in Los Alamos that Germany did not produce the bomb and when General Groves said in a private conversation that the bomb would be useful in dealing with the Russians after the war.

Page 3: You are right that Bohr didn't play an important role in the building of the atomic bombs, but he was definitely involved. He arrived at Los Alamos at the end of 1943 when the Manhattan Project was already well advanced but he still made some small but important contributions to the ignition mechanism for the Pu bomb. And he did not leave the Manhattan Project, as Rotblat did, when it became clear that Germany would not have the bomb. Bohr remained at Los Alamos as an adviser to Oppenheimer and General Groves until June 1945 when he left in order to return to liberated Denmark and to his Copenhagen institute. Thus, I don't think that Frayn distorts history when he mentions Bohr's involvement in the Manhattan Project. Of course, Bohr's motivations for working on the bomb were very honorable, and Frayn does not deny that.

It is true that Churchill, after his conversation with Bohr, suspected Bohr and was afraid that Bohr might give secrets to the Russians, and even considered having him detained. But that never happened. Bohr was never excluded from Los Alamos, as you suggest. From there he made another trip to London in March of 1945 in a second futile attempt to persuade Churchill to accept international control of nuclear energy. This time Churchill did not even receive him. Bohr returned to the US and wrote another memorandum to Roosevelt, but Roosevelt died before he could read it.

I do not think you are completely right when you say that the scientists had no influence on the use of the bomb. Oppenheimer and Fermi, among others, recommended the use of the bomb on Japan, and Oppenheimer gave detailed instructions as to the optimum height of explosion, the necessary weather conditions etc. But I agree that in 1945 only the president of the US could have stopped the use of the bomb.

Page 4: The first paragraph contains several inaccuracies. The names of the Nazi physicists and Nobel Prize winners were Stark and Lenard, not Leonard. Himmler's father and Heisenberg's father as well as grandfather had been teachers at classical high schools (Humanistisches Gymnasium), not at elementary schools. (Heisenberg's father later became a well-known university professor of Byzantine philology.) It is not correct that Heisenberg "led" the German nuclear program. He was not in charge, he was just the most prominent of the participants. Later he became the leader of one of several groups involved which competed with each other for the scarce resources of natural uranium and heavy water available. The official leaders of the program were, at first, in Army Ordnance then in the Reichsforschungsrat under Prof. Abraham Esau. Finally the program came under the leadership of Prof. Gerlach in his capacity as "Beauftragter des Reichsmarschalls (Göring) für die Kernphysik". Gerlach was Heisenberg's "boss" in the program. Before the war Heisenberg had been a reserve soldier in the Mountain Infantry (Gebirgsjäger). At the beginning of the war in 1939 he was drafted but, to his surprise, not to the Mountain Infantry where he had already served one year before as a soldier during the Sudeten crisis, but to Army Ordnance. The scientists of Army Ordnance had heard about nuclear fission. A group of physicists and chemists, including Otto Hahn, Bothe, Gerlach and others, but not Heisenberg, had been assembled by them to discuss whether the recently discovered fission of uranium could have military applications which could become significant during the war. Heisenberg was assigned to that group and given the task to make a theoretical study of the problem. It was not at his own initiative. But it is true that Heisenberg did not refuse. Weizsäcker had explained to him the advantages of taking part in this project: Exemption from real military service for himself and for his young collaborators, funds for doing interesting physics, participation in a project of potential great military and economic significance which would give them, as technical advisers, some influence on its applications which Weizsäcker hoped to use in a peaceful sense. As mentioned below, Weizsäcker admitted later that this was a terrible delusion.

I don't think it is correct to say that Heisenberg did not see any problems in Hitler's victory. He just thought, looking at the situation in September of 1941, that it might be unavoidable. Incidentally, Einstein thought the same at that time. According to the memoirs of Katia Mann, wife of Thomas Mann who, living next door to Einstein in Princeton in 1941, was acquainted with him, Einstein believed that the Germans would easily beat the Russians, as they had done in the First World War. It is true, however, that Heisenberg thought that a domination of Europe by Stalin would be an even greater evil than a domination by Hitler. At that time, Auschwitz was not yet known but Stalin's concentration camps and massacres were. Even Anthony Eden, British Foreign Minister, was doubtful on June 22, 1941, when Hitler invaded the Soviet Union, until then Hitler's ally in the division of Poland and the cessation of the Baltic States, and of parts of Czechoslovakia and Rumania to the Soviet Union, whether Britain should support Stalin. After all, British volunteers had just fought alongside Finnish troops in the Winter War against the Soviet Union. Eden abhorred Stalin as much as Hitler. Churchill had to use his authority as Prime Minister to order support of the Soviet Union. But even Churchill seems to have compared Stalin to the Devil. I remember having read that Churchill said that if Hitler had invaded Hell he, Churchill, would have gladly supported the master of Hell, the Devil. Thus, anti-Stalinist feelings were not restricted to Germany in the 1930s and 1940s, and for quite some time it was an open question for many people in Europe, also in France, whether Hitler or Stalin were the greater evil. Heisenberg certainly detested the Nazi system under which he felt forced to live. He saw great problems in a potential victory of Hitler but he also saw great problems for Germany following its defeat. Like many conservative Germans, he would have preferred a moderate peace treaty between the allies and a new non-Nazi German government, sparing Germany the painful consequences of unconditional, total defeat. You must remember that the resurrection of Germany after defeat was not foreseeable at all. To be expected was the dismemberment of Germany and the execution of the Morgenthau plan.

Regarding the rescue of the Danish Jews, it is now known that it was the German official Duckwitz who warned the Danish underground in 1943 of the imminent deportation of the Danish Jews. Bohr was informed and fled to Sweden in a small boat. After the war Duckwitz became German ambassador to Denmark.

Page 5: Regarding "Weizsäcker's self-aggrandizing propaganda" I must repeat that both Heisenberg and Weizsäcker wrote long letters to Jungk (in Weizsäcker's case 19 pages of criticism, if I remember correctly) which Jungk did not take into account when he prepared the Danish and English editions of his book. He just published the laudatory part of Heisenberg's letter, giving the wrong impression that Heisenberg had agreed with everything Jungk had written.

Weizsäcker never said that the "German nuclear scientists kept their hands as clean as possible", as you suggest. In fact, as mentioned above, Weizsäcker did express a sense of guilt when he repeatedly said that he took a grave risk which he should never have taken when as a young man of 27 he decided to study the possibility of bomb making in the naive assumption that Hitler would be forced to listen to him when he, Weizsäcker, knew how to make these bombs. He hoped that he could then convince Hitler that the potential existence of the bomb had made the institution of war obsolete and that Hitler should adopt peaceful policies. He realized later that this idea was a terrible mistake because the Nazis in their brutality would never have listened to political advice given by technical experts. Therefore, he and Heisenberg were extremely happy when Heisenberg's work showed that nuclear weapons were not feasible for many years to come and when the project was dropped. Neither he nor Heisenberg ever said that they did not work on the bomb for moral or ethical reasons. The moral question never came up because the project was ended for technical reasons.

Your quotation that "History will record that the peaceful development of the uranium engine was made by the Germans under the Hitler regime, whereas the Americans and the English developed this ghastly weapon of war" is what Weizsäcker said at Farm Hall before the German scientists knew that the Americans had also built reactors. At that time they assumed that the Americans had concentrated on making a bomb from separated U 235 while in Germany they had devoted their efforts to building a reactor for power production from natural uranium and heavy water.

Neither Heisenberg nor Weizsäcker ever denied the horrors of the Nazi regime and they would not have been even remotely inclined to suggest, as you do on page 6, that "one could forget or forgive what were Hitler's crimes and intentions." You are quite right, on the other hand, that Heisenberg, very probably, would not have been able to prevent the building of an atom bomb for Hitler if that would have been technically feasible with the resources available in Germany during the war. Even if he would have accepted "martyrdom" there would have been other physicists and engineers who would have done it. That is, I repeat, why Heisenberg was so relieved when he found out that the technical difficulties appeared to be insurmountable. He did not make any attempt to overcome them by proposing a crash program but was quite happy to resign to a relatively small reactor project, devoting part of his time to the study of cosmic rays, S matrix theory and philosophical questions. He did not have to make efforts to prevent work on atomic weapons because there was no risk that such work could succeed. He never claimed after the war that this was so due to his "sabotage". On the contrary, he always said that he and his German colleagues had been extremely lucky that the ethical question never came up for them. Heisenberg also said and wrote that the ethical situation of his American colleagues was quite different because they were working for a good cause against the evil Nazi system. Again, it was Robert Jungk who did not report correctly what Heisenberg and Weizsäcker had told him.

On page 7 you give, I think, a correct description of why Heisenberg did not emigrate before the war. Like his older colleagues Max Planck and Max von Laue he stayed in Germany to save as much as he could of German science and culture against the destructive influence of the Nazis. Just as Bohr was a Danish patriot, Heisenberg was a German patriot. He was not a nationalist because nationalists consider their own nation superior to other nations, and Heisenberg, as a member of the international family of physicists and with his friends in so many nations, many of them Jews, was immune to nationalism.

You might ask: If that is so, how can one explain Heisenberg's remark during a lunch-time conversation at Bohr's institute in 1941? He is reported to have regretted German occupation of Denmark, Norway, Belgium and the Netherlands but regarding the Eastern European countries to have expressed the view that they are known to be unable to rule themselves. Møller replied: "So far we only learned that Germany is unable to rule itself!" One has to remember that the view expressed by Heisenberg here on the countries of Eastern Europe had been the general view in Germany, and perhaps elsewhere, for centuries. Since the end of the 18th century and up to 1918, just about two decades before Heisenberg's visit to Copenhagen in 1941, Poland had been divided between Russia, Austria and Prussia. The Baltic states had been part of the empire of the Czar. Czechoslovakia, Hungary and parts of Yugoslavia and Rumania belonged to the Habsburg Empire. Before 1795 the position of the Polish king was very weak, and so was the Polish parliament. Any nobleman could veto its decisions. Between the wars, in the 1920s and 1930s, Poland was governed by the dictatorial regime of Pilsudski, and Hungary by that of Admiral Horthy. Yugoslavia and Rumania did not have democratic governments either. When, in July 1915, during the general discussion of German war aims, 191 liberal and moderate German scientists and scholars, among them Max Planck and Albert Einstein, signed a petition against German annexations in the West, arguing that the incorporation or affiliation of politically independent populations or of populations used to independence was to be rejected, they left open the road to territorial expansion in the East. Thus, Heisenberg's remark had nothing to do with approving of Hitler's aggressive policies, it was just a historical reminder based on a view that had been generally held, at least in Germany, for a very long time.

In any case, I agree with the last sentence of your paper: There is still room for another excellent play.

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COMMENTARY

Call for Nominations

The Forum's election schedule does not coincide with the APS election schedule. Our present schedule denies Forum representation on the APS Council for the first half-year of our Councilor's term. For this reason, the election of the 2004 officers will take place 6 months earlier, with the printed ballot appearing in the July issue of *Physics and Society.* The next ballot will decide the following positions: Vice-Chair, Secretary/Treasurer, Forum Councilor, and Executive Board (2). Please send nominations by May 1, 2003 to David Hafemeister at dhafemei@calpoly.edu, Physics Department, California Polytechnic State University, San Luis Obispo, CA 93407, (805) 544-5096.

Remarks from the Chair

Andy Sessler

Dear Fellow FPS Members,

There are two purposes of the Forum on Physics and Society. The first is to develop sessions at the APS Meetings that deal with those issues where physics and society intersect. The topics may be those where society has an impact on physics (funding laws, visa matters, etc.) and those where physics has -- or should have -- an impact on society (missile defense, economic impact of research, educational outreach). The second purpose is to produce a Newsletter that brings the very matters mentioned to the attention of our members, many of whom desire a deeper treatment of these matters, or can't attend our sessions. In addition our Newsletter has other features such as book reviews and articles on matters not covered in our sessions.

In order to accomplish all this we have a rather elaborate structure of elected vice chair (later to become the chair-elect, chair and past-chair), secretary-treasurer, elected representative to the APS standing committee of council, POPA, representative to the APS Council and members of our Executive Committee. In addition, we have an appointed Editor of our Newsletter, and many appointed volunteers serving on the Editorial Board, a Fellowship Committee, a Nominating Committee, a Program Committee, an Awards Committees, up-dating our web site, etc. All of this is set forth in our by-laws that are posted on our web site. Furthermore, in order to facilitate ever-new people becoming our officers and volunteers we have made a Handbook describing duties and needs. This also is posted on our web site.

But, as I said earlier, the output products are our Sessions and our Newsletter. Both are of excellent quality and I will refrain, here, from discussing the very many subjects of vital importance that are covered. This year we have been involved in 12 different sessions (primarily because we have made connections to many other units and have developed – to mutual benefit – joint sessions). Most (8) were at the April Meeting, the remainder at the March Meeting. We have not yet penetrated the other meetings such as the Plasma Meeting or the Fluid Dynamics Meeting. I would like to see that happen. I believe we can do that by using our Program

Committee and, most importantly, assuring that it has wide representation. (In the last few years, that Committee has been let languish with all of its tasks falling to the chair-elect.)

The Newsletter, after more discussion and machination than you can believe, is now easily reached from the APS Home Page. Hopefully, even those not members of the FPS are now finding the Newsletter and, more importantly, finding it interesting. Maybe they will even join our Forum!

Keeping the Forum "going" is a big task. Besides our formal meeting once a year (at the April Meeting) we have conference telephone calls through out the year. Many of the members of the Executive Committee work very hard and, as is usually the case, their efforts are unappreciated by most of those who benefit. I want to be amongst the first who gives them a vote of thanks. I suspect that many others would join me.

We do need more volunteers: Everything from being willing to "run" for various offices to being members of the editorial board, the fellowship, sessions, awards and nominating committees. The simplest way is to send me an e-mail saying what you would be willing to do. Sooner, or later (and it may be "sooner") we shall use you!

Andy Sessler
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Nuclear Policing the World

Nina Byers

The following may be of interest to physicists as we face the problem of proliferation of nuclear weapons and the threat of nuclear war. Our predecessors more than fifty years ago foresaw the predicament we find ourselves in today. The Franck Report which was not declassified until many years after the end of WWII attests to the prescience of such people as James Franck and Leo Szilard. They along with Niels Bohr and Albert Einstein firmly believed in an internationallist approach to the problem of controlling nuclear weapons proliferation. Others disagreed. Arthur Compton, for one, believed in a nationalist approach. The following is a brief account of this difference and how it played itself out in 1945. It is extracted from an article published in the November 2002 CERN Courier (http://xxx.lanl.gov/html/physics/0210058). References to the historical documents can be found there.

In 1943 fear that the German war machine might use atomic bombs was abating and among physicists another fear was taking its place - that of a postwar nuclear arms race with worldwide proliferation of nuclear weapons. Manhattan Project scientists and engineers began to discuss uses of nuclear energy in the postwar world. Niels Bohr, Leo Szilard, James A. Franck and others launched a concerted effort to lay groundwork for international control of the technology. They tried to persuade policy makers not to base their decisions on short range military expediency alone but also take into account long range consequences. They foresaw a postwar nuclear arms race and the proliferation of such weapons among many nations, large and small. They also anticipated the danger of non-national entities acquiring such weapons. The main message of these people was that worldwide international agreements would be needed to provide for inspection and control of nuclear weapons technology. It was given in meetings and documents whose contents were then highly classified but are now in the public domain. [1]

The political philosophy that propelled Bohr, Franck, Szilard and their colleagues to suggest such an internationalist approach to the problem was not universal among physicists in the Manhattan Project. Indeed Arthur Compton, Director of the Metallurgical Laboratory, had a nationalist viewpoint which he expressed, for example, in his book *Atomic Quest* (Oxford University Press 1956). He wrote "In my mind General Groves stands out as a classic example of the patriot. I asked him once whether he would place the welfare of the United States above the welfare of mankind. 'If you put it that way,' the General replied 'there is only one answer. You must put the welfare of man first. But show me if you can,' he added, 'an agency through which it is possible to do more for the service of man than can be done through the United States.' "

In 1946 Compton suggested how to keep the peace in an essay entitled the Moral Meaning of the Atomic Bomb published in a collection *Christianity Takes a Stand* (reprinted in *The Cosmos of Arthur Holly Compton*, M. Johnston ed., Alfred A. Knopf New York 1967). He wrote

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[1] References and further details can be found in N. Byers, *Physicists and the Decision to use the Bomb*, CERN Courier, November 2002. This paper is also available at http://xxx.lanl.gov:80/html/physics/0210058.

"It is now possible to equip a world police with weapons by which war can be prevented and peace assured. An adequate air force equipped with atomic bombs, well dispersed over the earth, should suffice. ...we must work quickly. Our monopoly of atomic bombs and control of the world's peace is short-lived. It is our duty to do our utmost to effect the establishment of an adequate world police ... This is the obligation that goes with the power God has seen fit to give us."

This is in stark contrast with the views of Niels Bohr. In 1944 Bohr met with President Roosevelt and Prime Minister Churchill, separately, urging that they consider open sharing with all nations the nuclear technology being developed in the Manhattan Project to lay groundwork for international control of atomic energy. His suggestion was officially rejected by the two leaders in an Aide-memoire signed September 1944 at their Hyde Park meeting. Einstein learned of this failed effort of Bohr and suggested to him that they could take steps to inform leading scientists whom they knew in key countries. Bohr felt they should abide by wartime security restrictions and not do this.

After Roosevelt died in the spring of 1945, a committee, the Interim Committee, was formed to advise the President and Congress on the use of nuclear energy. Scientists and engineers in the Metallurgical Lab submitted a report to that Committee which now is famous as the Franck Report. It was transmitted by Lab Director Arthur Compton to Secretary of War Stimson, chair of the Committee. In his letter of transmittal, dated June 12, Compton expressed criticism of the Report and said he would give it to the Scientists Panel to consider. The Panel consisted, in addition to himself, of J. R. Oppenheimer, E. O Lawrence, and E. Fermi. The Panel's report was submitted to the Committee four days later. It disagreed with the recommendations of the Franck Report (see below) and instead agreed with the Interim Committee's advice "that the bomb should be used against Japan as soon as possible." The Committee had unanimously agreed on June 1 to offer this advice at the recommendation of James F. Byrnes, President Truman's designated Secretary of State. Byrnes was a member of the Committee as was Karl Compton, President of MIT and Arthur's brother. Historians believe Truman met with Byrnes later that day and made this decision. Clearly the census the Committee had reached June 1 was not known to the authors of the Franck Report. Their Report is dated June 11.

The Franck Report found the "use of nuclear bombs for an early, unannounced attack on Japan inadvisable. If the United States would be the first to release this new means of indiscriminate destruction upon mankind, she would prejudice the possibility of reaching an international agreement on the future control of such weapons. Much more favorable conditions for the eventual achievement of such an agreement could be created if nuclear bombs were first revealed to the world by a demonstration in an appropriately selected uninhabited area. ..."

This historic record shows the diversity of physicists' political philosophies. It no doubt still exists. The political spectrum to be found in our community is, I believe, as wide as in the communities in which we live. There is no reason to believe that on political issues we think alike. As citizens of a political democracy we have the right and obligation to express our opinions, and in these perilous times I believe we should be doing so.

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(References and further details can be found in N. Byers, *Physicists and the Decision to use the Bomb*, CERN Courier, November 2002. This paper is also available at <http://xxx.lanl.gov:80/html/physics/0210058>)

LETTERS

Dismay with Previous Commentary

I read the article entitled: "The Physics of Religion" with growing dismay. Firstly the author states that: "world peace cannot occur until all major powers have separated Church and State". However, later in the article, he writes: "This can be ended by separation of Church and State in the US, as in other countries (i.e. UK, Germany, etc.)".

Church and State have been separated by federal law since the inception ofthe United States. Because of this separation, for instance, religion ma not be taught in public schools. However, there is no separation of Church and State in the UK. The Queen is the head of the Anglican Church, which is the State Church. The writer seems to be uninformed concerning his subject.

Furthermore, he states earlier in the article: "Most true scientists do no try to assign human intelligence to some supreme being as the creator of the universe." Later he states that : "religion is assertive (i.e., dogmatic and intolerant of questions". In my opinion, by the use of the phrase: "most true scientists ...", he shows himself to be assertive and dogmatic.

I am a scientist (PhD (physics) Johns Hopkins) and a committed Christian. In addition to my scientific degrees, I have BTh(Hons) in theological ethics from the University of South Africa. I am a Canon of the Church of the Province of Southern Africa, which is equivalent to the Episcopal Church in the US.

A friend of mine, also a physicist and a Christian, once said that he found no conflict between science and religion; both books were written by the same author.

I concur that many wars are, sadly, the result of religious differences. But uninformed articles will not further the goal of peace.

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Vigorous Exception

I take vigorous exception to John T.A. Ely's commentary on "The Physics of Religion" in the January 2003 issue of Physics & Society. While I can agree with his primary point that separation of church and state is a desirable political construct for all societies as a means of reducing conflict, some of his basic assumptions are very wrong. The one false assumption I wish to address here is implied through several of Ely's statements, and can be summarized as follows: " All religions are lies and fantasies, and no educated person, especially a physicist, could possibly believe any religious tenets."

As a physicist for 38 years, and a Christian for 50 years, I find such an assumption absurd. Most human beings, including physicists, realize that there are at least two aspects of reality: physical and spiritual. Physics (all science) can treat only physical reality, but this does not imply that spiritual reality does not exist. If Dr. Ely (or anyone else) chooses to believe that a spiritual realm does not exist, and that human beings are nothing more than the sum of their wavefunctions, he is free in our society to make that choice, and this is good. But such a choice, even if it were to lead to a reduction of religious influence in political and international affairs, can hardly lead to "world peace. The vast majority of wars since the Middle Ages have been fought for reasons of greed and "practical national interests," rather than for religious motives. Only today's radical Islamist terrorists (whom, it should be noted, have perverted Islam for their own purposes) are clear exceptions to this rule

No doubt, improved scientific education would benefit all peoples everywhere. But to assert that the goal of such education would be to eradicate all religious belief, and that this would lead somehow to universal peace, completely misses the reality that human beings are more that agglomerations of atoms, and is a form of dogmatism equal to that which Ely detests. Science cannot eradicate selfishness and greed any more than it can prove whether God does or does not exist.

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Censor Letters?

I realize that there is a value in allowing as many people as possible to express their opinions in _Physics & Society. However, some minimal level of fact-checking and editorial discretion should nevertheless be exercised. The astonishingly ignorant screed by Prof. John Ely in the current issue should not have been published in its current form. Its summary is simply factually wrong: both the UK and Germany have established state religions (the Church of England in the UK, and the Catholic and Protestant churches in Germany), while the US was founded as the first nation without a state religion, regardless of the ill-advised behavior of some current occupants of high office.

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You May Not Read Yourself!

During my professional carrier I had been working frequently in US National Laboratories. Once, I was preparing a paper for publication in an international journal. For this paper I needed some data I had published previously; I looked for this Journal in the Library of the National Lab., but I did not find it in the shelf.

So, I went to the librarian and asked for this paper. After some minutes she returned blushing and said:

"Sorry, Sir, this material is classified. You may not read it!"

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Risk assesment/risk management

I read the July review of the book "Inviting Disaster" and was wondering if there is a reading list the reviewer could recommend on the topic of risk assessment and management including common concepts and the key steps in failure analysis. Hope you can help.

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Aviva Brecher responds:

I am glad that somebody reads the stuff! Here are a few resources, to help you customize to your problem needs. RA/Rm is customized depending on whether a qualitative risk ranking (as DOD uses) suffices, or if enough data exists for a probabilistic risk assessment. OSTP and Congress have tried to standardize procedures across agencies, but failed miserably because the depth of analysis depends on the nature and severity of consequences (equipment or business loss vs human life loss, or disease).

[1] Website of the Society for Risk Analysis at www.sra.org <http://www.sra.org>

[2] If you go to the Nuclear Regulatory Agency website there are a lot of classic Fault Tree Analysis handbooks, like the oldie but goodie NUREG-0492 at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0492/index.html and similar at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/index.html

[3] My favorite is "System safety Engineering and management" by Harold Roland and Brian Moriarty, Wiley and Sons (1983?)

[4] The NRC published several comprehensive reviews of RA/RM techniques and practices, such as the:

- 1983 Risk Assessment in the Federal Government
- 1989 Improving Risk Communication
- 1993 Issues in RiskAssessment
- 1994 Science and Judgment in Risk Assessment
- 1996 Understanding Risk: Informing Decisions in a Democratic Society

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Pro Nuclear Power

In the January 2003 Physics & Society, HA Feiveson has an article against nuclear power. The article, in effect, could cause future disasters to our children and grandchildren – and to the world!

In the coming decades it is projected that we will run out of oil and gas; and in the next century, coal. Further, these fossil fuels could cause global warming - additional disasters to the world.

There is only one solution – nuclear power. Solar and wind power can provide some needed energy but they require over 50 square miles to produce a thousand megawatts of electricity, verses a coal or nuclear plant which takes a couple of acres. Further, solar plants can't operate when the sun goes down, or the clouds come out; and wind power dies when the wind goes down. Thus their public energy is limited.

It is projected that the world population will rise from 6 to about 10 billion people in the next 50 years; and if the world energy use reaches a third of the energy per person now used in the US then world energy will triple. The only solution is nuclear energy.

Nuclear plants built to US requirements have not harmed a single person in the public – including Three Mile Island. (Chernobyl would not have been allowed here; and Russia is now accepting our safety requirements.) Further, nuclear power with the breeder reactor can provide world energy for thousands of years; and almost indefinitely with uranium from seawater. And the wastes from breeder reactors will decay in only a few hundred years, as compared to the thousands of years for our present thermal reactor wastes.

In summary, unless fusion turns out successful, the only way to keep our nation and world healthy is to expand our nuclear energy worldwide; and, on a worldwide basis maintain the operating means and world safety requirements that we now meet.

In closing, let us note that every technical item has problems. It is hard to understand why Mr. Feiveson does not oppose the use of automobiles, which now kills 50,000 people per year in the US. It is very unlikely that nuclear power will ever do this.

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Bertram Wolfe is a Ph.D. physicist, a member of the National Academy of Engineering, a Past President and Fellow of the American Nuclear Society, a Fellow of the American Association for the Advancement of Science, and a Professional Engineer in California. He has received a number of honors for his work in the nuclear energy field. Before his 1992 retirement from GE he was a VP and head of General Electric's nuclear energy organization. He has since been on a number of Boards of Directors and advisory committees. He now has no monetary connection to Nuclear Energy.

Point/No Counterpoint

Readers who are interested in seeing two views of the nuclear power generation debate are invited to see two websites as well as a reaction to one of them. The site www.ieer.org/sdafiles/ has an article from the November 2002 issue of "Science for Democratic Action", and it describes the results of a health survey in India near a nuclear power plant. The site www.ecolo.org/media/articles/articles.in.english/canberraTimes17-10-02.htm is a pro-nuclear article by Bruno Comby. I invited Comby and IEER to provide P&S with a response to the other's article. Comby provided a response to IEER's article, but IEER did not provide a response to Comby's. We publish below the response of Comby, after slight editing. -J.M.

The article entitled "Health Survey Around an Indian Nuclear Power Plant"(www.ieer.org/sdafiles/) was published in "Science for Democratic Action" a newsletter of the Institute for Energy and Environmental Research (IEER).The authors of this paper, Doctors Gadekar, are the editors of "Anumukti, A Journal Devoted to Non-Nuclear India," which proclaims itself "South Asia's Only Anti-Nuclear Magazine." They say that they became confirmed anti-nuclear activists after the 1986 Chernobyl accident.

"Health Survey Around an Indian Nuclear Power Plant" is a report of a survey made in 1991 on illnesses including fevers of short and long duration, breathing difficulties and persistent coughs, body aches and pain in joints, digestive problems, skin diseases, weakness and debility, solid tumors, conjunctivitis and cataracts, and acquired deformities and polio, among a sample of about 2500 persons living within 10 km of the Candu nuclear reactors at Rawatbhata , the Rajasthan Atomic PowerStation , as compared to a similar number living over 50 km away. The first reactor went critical in August 1972 and commercial in December 1973 while the second became commercial in April 1981.

In EVERY category, they found more disease among the first group than among the second, the differences ranging from barely significant to as much as a factor of six. None of these conditions is known to be connected with chronic exposure to ionizing radiation; but some occur under exposure to extremely high doses, much higher than are ever likely to be encountered in the vicinity of a nuclear power station, except perhaps in the event of a major accident like Chernobyl. The report states : "The most significant differences in health were related to untoward pregnancy outcomes. These miscarriages, still-births, deaths among newborn babies and congenital deformities amongst both the living and those who had died within the last few years." Yet Table 3 *(in the paper)* shows that such differences between nearby and distant villages existed before 1971.

A serious shortcoming in this report is the absence of any measure of the ionizing radiation or radioactivity in the vicinity of the nuclear power plant or in the nearby and distant villages of the study. This omission is surprising since Dr Surenda Gadekar is a nuclear physicist who has held a post-doctoral research position at Iowa State University.

The report was published in International Perspectives in Public Health, Volume **10** (1994), and there seems to have been no echo to be easily found on the Internet. The editor of that periodical is Dr Rosalie Bertell, an anti-nuclear activist; her latest cause is based on the notion that depleted uranium ammunition is the origin of the nebulous Gulf War and Balkan War Syndromes. (See http://www.ccnr.org/bertell_bio.html and http://www.ratical.org/radiation/RBanNun.html)

The only external reference cited in this paper is a report by WISE, the Worldwide Information Service on Energy, which presents itself as a neutral organization. In fact, WISE is known to be closely related to Greenpeace in its personnel, its locations, and its finances.

Let me note finally that IEER is an organization which usually presents anti-nuclear views. Their views are not neutral. I find their writings often to be pseudo-scientific in an attempt to gain legitimacy. It is their privilege to hold anti-nuclear views, but their readers should be aware of their consistently anti-nuclear bias.

In summary, one is reminded of the caution addressed to a would-be investor, "If it sounds too good to be true, it probably is". In the case at hand, "If it sounds too terrible to be true, it probably is."

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NEWS

New Co-Editor

The Executive Committee of the Forum on Physics & Society has approved the appointment of Jeffrey Marque, Senior Staff Physicist at Beckman Coulter Corporation in Palo Alto, California, as a co-editor (with Alvin Saperstein) of the P&S Newsletter. Jeff served as the news editor for about two years, starting about five years ago but then left that post "...to spend more time with my family...". After a bit of coaxing in late 2002, Jeff agreed once again to be our news editor. And after even more coaxing, he agreed to be Alvin Saperstein's co-editor starting in 2003. Jeff's remarks describe the pathway to his decision, "After I left the P&S editing staff a few years ago, Al Saperstein and his colleagues continued to put out a fabulous publication, issue after issue, for the P&S community. It was the consistently high quality of Al's work, as well as the ever growing importance of issues at the interface of physics and society, that made me decide to take the plunge and join Al's ranks. In addition to the obvious challenge of just getting all the editing work done, there is the challenge of maintaining the very high quality of the publication. Another potential source of challenge for P&S editors in the immediate future is the controversy generated by some of the Bush Administration's policies and decisions regarding National Missile Defense, global warming, nuclear-fueled electricity production, fuel efficiency in cars, etc. Providing balanced coverage of these and other issues will require diligence."

"I apparently accepted the co-editorship of P&S during a time when relatively momentous issues involving physics and society (e.g., self-censorship of science journals!) are coming to the fore. What I'm struggling with is a series of questions concerning the proper role of an editor and of our newsletter: What are the proper constraints that we place on ourselves regarding the publication of pieces concerning subjects that are inherently political? Under what circumstances, if any, do we advocate a particular viewpoint concerning a controversial topic? How are our policies and decisions constrained by our being part of APS?

Back in the MacArthy years, many people in positions similar to ours had to make difficult decisions. Those decisions sometimes involved not only the appropriateness of expressing a particular viewpoint but also significant personal/professional risk. Back then, the war on Communism was used to justify all manner of policies and actions by the government. Now, we seem to have entered an era in which the war on Terrorism is leading in similar directions. How do we, as editors, react to such developments? Do we steadfastly publish "both sides" to every issue, or do we sometimes take a definite stand? I need guidance here! I welcome the views of all my P&S colleagues." (JM)

Publish vs. Perish

A statement concerning national security, entitled *Statement on Scientific Publication and Security*, was signed by over 30 editors of scientific journals and released on February 15, 2003. The statement, the full text of which can be found at http://www.fas.org/sgp/news/2003/02/sci021503.html and which is scheduled for publication in Science, Nature, and PNAS, concerns editors' voluntary witholding from publication of articles that, in the editors' views, could aid terrorists seeking to develop biological weapons of mass destruction.

The *Statement* consists of a Preamble and four subsequent statements. The preamble opens with a declaration of the importance of refereed scientific works to the welfare of mankind. It then goes on to describe how the events of September 11, 2001, and the subsequent anthrax attacks, caused some scientists and politicians to be concerned about new scientific information getting into the wrong hands. A one-day workshop at the National Academy of Sciences, held on January 9, 2003, specifically addressed the issue of how certain new biological scientific findings might need to be withheld from publication. The next day, a group of editors, scientist authors, and government officials met to discuss implementation possibilities.

Four subsequent statements within the *Statement on Scientific Publication and Security* are outcomes of the January 9 and 10 meetings. The first statement reiterates the importance of peer-reviewed scientific publication and, specifically, of the need to publish in sufficient detail to allow reproduction of scientific investigations by readers of journals. The second statement mentions the conflicting needs to publish biological science that can benefit anti-terrorism defense and to not publish science that can be subject to "potential abuse". The authors then declare their commitment to "dealing responsibly and effectively with safety and security issues that may be raised by papers submitted for publication..."

The third statement urges scientists and editors to consider the design of processes to effectively deal with these conflicting needs, and it mentions the fact that certain journals have already devised such processes that can be used as models by other journals. The fourth statement states that, in the event that an editor concludes that "the potential harm of publication [of a particular paper] outweighs the potential societal benefits" that the paper should be modified or else not published at all. The fourth statement concludes that journals and scientific societies "can play an important role in encouraging investigators to communicate results of research in ways that maximize public benefits and minimize risks of misuse."

[Editor's note: The idea of self-censorship in peacetime by civilians is exemplified by Leo Szilard's conceiving of nuclear chain reactions in 1933, in London. After a few years of attempting to find the funds and venue to research his idea, he wrote to Rutherford in 1936, "...the feeling that I must not publish anything which might spread information of this kind – however limited – indiscriminately has so far prevented me from publishing anything on this subject." For further details, see <u>Genius in the Shadows</u> by William Lanouette.]

Controversy: Log vs Linear Plots

The news section of Science magazine, Volumn 299, January 10, 2003 contains an article (page 181) about alleged data reporting distortion concerning smallpox eradication by Donald A. Henderson, now a senior adviser to the Bush Administration. For close to a year, Yale University mathematician Edward Kaplan has reanalyzed small pox incidence data that were originally published in 1971 by William Foege (now a consultant to the Bill and Melinda Gates Foundation) and in 1975 by Foege and Henderson. Foege and Henderson claimed in their papers that an eradication strategy called ring immunization is very effective and, in fact, essential for eradication. Kaplan has argued that the original data show that ring immunization is far less effective than mass immunization, and that only by means of graphical sleights-of-hand could Foege & Henderson make it appear that ring immunization is effective.

In ring immunization, smallpox victims are isolated, followed by the immunization of everyone with whom the victims came in contact. In mass immunization, everybody is immunized. A graph published in the 1971 and 1975 papers purports to show a precipitous decline of smallpox cases following commencement of ring immunization. Kaplan claims that the following tricks only make it appear that a sharp decline occurred as a result of ring immunization: 1) The use of a semi-log plot (of #cases vs. time and of % unvaccinated vs. time), which had the effects of masking the extent of immunization and of exaggerating the decline in smallpox incidence, and 2) the reporting of ratio of reported to “expected” cases based on years, before 1968, when vaccination coverage was much lower. Kaplan re-plotted the original data using a linear-linear plot of the number of actual cases, and it appears that the decrease in the number of cases falls in lockstep with the decrease in the unvaccinated fraction of the population. In Kaplan’s graph, the effect of the introduction of ring-immunization, in 1968, appears unnoticeable.

Interestingly, Henderson is reported in the article to have said, regarding his semi-log plot, “I’ve always had difficulty with that graph myself.” as well as, regarding Kaplan, “Kaplan doesn’t understand what he’s talking about.”

According to Kaplan, others in the Bush Adminstration are interested in his results from analysis of the smallpox eradication battle in India. He claims that those results support his claim that ring vaccination is not as effective as mass immunization.

Radiological Sciences and WMD

The first International Workshop on Radiological Sciences and Applications(IWRSA) will be held in Albuquerque, NM, USA, June 16-18, 2003. The theme of this workshop is "Issues and Challenges of Weapons of Mass Destruction (WMD)Proliferation". The meeting is an informal forum for scholarly discussion of important issues and to promote international cooperative projects in radiological sciences and technologies. The goals of the meeting are to identify the grand challenges and needs within the international community where radiological sciences and technologies can make a positive contribution, and to seek input from the participants on establishing an annual workshop for scholarly discussion of important international issues.

The workshop takes a multi-disciplinary approach that considers the technical and scientific problems as well as the policy, cultural, and socioeconomic issues. For additional information, please see the IWRSA web site at http://www.iwrsa.org.

Depleted Uranium Contaminates Bosnia-Herzegovina

SARAJEVO, Bosnia-Herzegovina, March 25, 2003 (ENS) - For the first time, a United Nations research team has confirmed that depleted uranium from weapons used in Bosnia and Herzegovina in 1994 and 1995 has contaminated local supplies of drinking water, and can still be found in dust particles suspended in the air. Depleted uranium is used in armour penetrating military ordinance because of its high density, and also in the manufacture of defensive armor plate.

For full text and graphics visit: http://ens-news.com/ens/mar2003/2003-03-25-04.asp

REVIEWS

Brotherhood of the Bomb
by Gregg Herken
Henry Holt and Company, 2002, $30, 448 pages, ISBN 0-8050-6588-1

This book traces the lives of Oppenheimer, Lawrence, and Teller. Now, some 40 or more years after the events described, the files are open, memoirs exist, and the historian/author was able to conduct interviews with many of those who lived through the times. The result is a comprehensive book that both reads exceptionally well and yet has 100 pages of small-print notes.

The book focuses on the three principles, but of course hundreds of others cross their lives and many of these are dealt with at great length. The emphasis is upon the personalities and the politics, but there are certainly plenty of technical details. For example there is much discussion of the early history of the cyclotron and of the laboratory that Lawrence developed, but the discussion of the operation of a cyclotron is limited to saying that particles are bent in a circle and that radio frequency fields (rf) are employed. Just how rf is employed is not described, but the Importance of the development of radio tubes, and powerful rf generators, is noted. Nevertheless, the primary emphasis is on the interaction of Lawrence with the University of California and with sources of private funding.

Similarly, Herken hardly mentions how an atomic weapon operates, but he devotes a good deal of discussion to the people involved, their personalities, the political machinations both before and during the project, the geographic location of various elements going into the bomb, etc. Despite the lack of technical detail, however, one learns technical things. For example, although the main emphasis is on the people and the locations and the rivalries and efforts, and ultimate performance associated with the various processes used during WW II to separate uranium (diffusion, centrifuge and electromagnetic), one learns that electromagnetic separation, or calutrons, were in fact the devices that separated the material for the Hiroshima bomb. This is not commonly realized, for after the Hiroshima bomb the electromagnetic method was not used, as the other two methods proved to be cheaper and simpler.

By proposing electromagnetic separation, and then making it work, Lawrence played a key role in developing the atomic bomb. He was the only scientist, of the few that spoke directly to Secretary of State James Byrnes, who advocated a demonstration to the Japanese of the power of the bomb, rather than its actual use.

A considerable part of the book is devoted to Teller's early history and to his later important role with the development of the hydrogen bomb. It is interesting to remember how Teller was supported in these efforts by Lawrence who built the Materials Testing Accelerator (MTA), a name chosen to confuse Soviet spies, to produce the tritium Teller needed and couldn't get (it was being used to build the stockpile). The MTA never produced anything, but Lawrence and Teller were successful in forming a second weapons laboratory in Livermore.

The 1950s McCarthy era and the related California oath are described in much detail. The trial of Oppenheimer is carefully delineated, with particular attention to the personalities, motives and actions. It is important to attentively read the careful history of Oppenheimer's association with communists--his brother was a member of the party--so as to better understand the events leading to his persecution.

The significant role of Lawrence in the arms race surprised me. Not only was he active in pushing the development of Teller's hydrogen bomb and founding Livermore Laboratory, which I knew about, but he was active on diverse committees and was, after Openheimer's removal, perhaps the senior active advisor to the government and played a crucial role in the cold war arms race. On the other hand he became active in arms control only in his last years. In fact this activity was instrumental in his early death. Teller, as we know, played a very large role in national defense after Oppenheimer and Lawrence left the scene. It is most interesting to repeatedly see his exaggerated concern about the Soviets and his excessive technological optimism. Rarely did technical reality justify his remarks, but this didn't seem to either phase him or disturb his contacts in the Department of Defense who continued to rely on his judgement.

I highly recommend this impressive book. The open files, the many interviews, the careful history, and the deep scholarship of Gregg Herkin have disclosed many new, and important, things. In addition, the book is an easy read. It is an interesting and important compliment to those many books that are more technically oriented. It was fascinating to me--and I had thought I knew everything there was to know about that period.

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A Convenient Spy: Wen Ho Lee and the Politics of Nuclear Espionage
by Dan Stober and Ian Hoffman
Simon & Schuster, 2001, 384 pages, $18.20, ISBN 0-7432-2378-0

I highly recommend reading this book, at least if you can imagine popping through the latest techno-thriller; this book is shorter and much more breathtaking. I myself re-read it several times, not in the least because the overlapping jurisdictions of different counterintelligence, prosecutorial and judicial offices, which dealt with the matter, is hard to remember and even harder to rationalize.

The authors, Dan Stober from the San Jose Mercury and Ian Hoffman from the Albuquerque Journal did an impressive job conducting hundreds of interviews with people from all parties to the conflict. As for the book's details of nuclear weapons design, I cannot vouch for their accuracy because I never possessed the necessary clearance and know even less than they do, but at least (and contrary to most techno-thrillers), the technical details are correct from the standpoint of college-level physics.

For the readers who do not remember the case, I recapitulate a few details. American intelligence in the late 1980s became aware, allegedly through intentional leaks by the Chinese, that the People's Republic of China possessed critical details of the design of W88 warhead—the most modern nuclear weapon in the U.S. nuclear arsenal—with the unspoken assumption that the PRC would use this knowledge for their own nuclear program. The subsequent U.S. investigation singled out Los Alamos as the warhead's design center. In the mid-90s, the investigation converged on the Los Alamos physicist of Taiwanese origin, Wen Ho Lee. During subsequent hearings and trials accompanied by media hoopla of national proportions, he pleaded guilty to one count of mishandling classified information. His guilt in the transfer of the design specifications of W88 was never established.

Wen Ho Lee was not a random target of spy insinuations. The authors detail how he and his wife had been investigated before for their contacts with the Chinese, which the authorities found improper. The FBI considered the allegations unlikely and dismissed them. His security clearance was not revoked at the time.

The authors eschew the conventional lore of the Wen Ho Lee story. They could have had an easy time displaying Notra Trulock, then the intelligence chief of the Department of Energy, as a villain and Bob Vrooman, former head of one of labs' security offices who opposed the spy revelations most consistently, as a hero. But the story is not one-dimensional, and the authors offer many conflicting theories of what happened and why. They list many arguments and counter-arguments in support of several story lines and do not provide a final answer. If only our political scientists would follow suit!

I want to pinpoint two subjects, which were at the core of the Wen Ho Lee controversy. Stober and Hoffman describe in excruciating detail the self-styled involvement of intelligence operatives, such as Trulock, in the matters of law enforcement, for which different standards of probability, proof and veracity apply. It is important to remember what happened at that time, when these days the government mindlessly breaks the barriers between intelligence gathering and law enforcement.

The question of whether Wen Ho Lee was a hapless victim of institutionalized racism and national security paranoia, a misguided attention-seeker, or a willing or unwilling instrument in the hands of Chinese intelligence services (they find the latter theory unlikely), remains further from a definitive answer when you close the book than when you open it. To keep the suspense, I will not tell you more about the book's conclusions.

However, Notra Trulock and a band of his loyalists could have only limited impact. As the authors correctly point out, almost all of their actions could be justified by wrong but perfectly understandable, if not legitimate, reasons. Yet the number of prosecutors and the lab officials who were willing to perjure themselves before the Federal bench misstating what exactly was classified and the precise value of the information Lee possessed, is scary. They also had their counterweights on the other side, most prominently Sig Hecker; director of the Los Alamos National Lab at the time the alleged espionage took place, and Bob Vrooman. The dramatic conversion of Republican Judge James A. Parker in the course of the investigation is pure Shakespeare.

There are several instances of black humor. For example, Wen Ho Lee's bail, conditions of which were supposed to be more stringent that are applied against the mob bosses who can be suspect in direct authorization of murders, was opposed on the grounds that he might be taken from his premises by an airborne commando force. The apparition of Chinese military helicopters in the New Mexico mountains, several hundred miles from any sea or border, may seem a little far-fetched, unless you are an avid reader of militias' lore--or a Department of Justice prosecutor.

This story would not have achieved national prominence if it were not for quite a few politicians who orchestrated leaks and went to the media with innuendos and outright lies about the affair. These included Secretary Richardson who according to the book authorized leaks to the *New York Times*; Congressman Schiff from Albuquerque who tried to elevate his own stature within the Republican party by describing the Clinton Administration as "soft on China"; Congressman Cox who penned the infamous Cox Report which was implicitly based on the patently racist idea that if the Chinese achieved breakthroughs in weapons technology they must have used foreign espionage, and Senator Lieberman who provided credence to these bizarre notions by peddling the Cox Report to the mass media. As you may observe, the rush to exploit the unproven spy allegations enjoyed bipartisan support.

These and many more went to the networks in droves to portray the entire Chinese-American community, mainland and Taiwanese alike, as virtual pawns in the hands of the Government of the People's Republic. Cox is quoted to have suggested that every(!) Chinese-owned business must be considered a front for the nefarious activities by the PRC, unless proven otherwise. I leave it to the reader to preview the implications of this unscrupulous exploitation of national security matters for politicking in the post 9/11 climate.

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Something New Under the Sun: An Environmental History of the 20th Century World,
by J.R. McNeill
New York, W. W. Norton & Company, 2001

This is an excellent reference book on worldwide and some local environmental trends. The structure is elegant and clever and it presents several innovative analyses. For example, in Part I "Music of the Spheres," McNeill divides his discussion of various environmental trends into chapters on the lithosphere, the pedosphere (Earth's crust) , the atmosphere, the hydrosphere, and the biosphere.

The book is not an easy read. A tedious tone is set in the preface where, after conceding that that environmental change is usually good for some and bad for others, McNeill confesses that sometimes he must "abandon all effort at Olympian detachment and label it degradation, despoilation, destruction" and he does so over and over and over in increasingly outraged tones. The density of detail and lack of consistent storyline in Part I (pages 19-267) probably discourages many readers from making it to Part II which has some of the more intriguing analysis. The level of detail also is sporadic. For example, after going on for two pages about Tampico, Mexico, including a listing of the number of liquor stores and bakeries, McNeill devotes only one sentence to the potential for information technology to change energy use.

That said, I was happy to have made it to his critique of economics and ecology on page 335. Of economic theory, he says "by 1960 [it] had crystallized as a bloodless abstraction in which nature figures, if at all, as a storehouse of resources waiting to be used. No reputable sect of economists could account for depreciating natural assets." Of ecologists he says " [they] pretended that humankind did not exist, they sought pristine patches in which to monitor energy flows and population dynamics. Consequently they had no political, economic, or ecological impact." While some economists are now seriously studying resource depletion, and some ecologists now study urban environments, this dichotomy persists to this day and undermines the foundations for sensible economic/enivironmental policy.

Finally, the book is crammed with intriguing facts. Some of my favorites: Bad News: in the 20th Century, the human population quadrupled and primary power consumption increased 16-fold. Good News: in the 20th Century, industrial output increased by a factor of 40 and since the latter half of the 20th century, energy intensity has declined. Cool Factoid: human beings...are about 18 percent efficient (at converting food-chemical energy, into mechanical energy). By comparison, horses are only 10 % efficient.

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