

Public Interest Report

The Future of Nuclear

Power: An interdisciplinary MIT study co-chaired by Dr. John Deutch and Dr. Ernest J. Moniz

Abridged study by John Deutch and Ernest J. Moniz

This report was released in July of this year and provided a comprehensive analysis of nuclear power related issues, covering economics, safety, and waste management as well as public attitudes toward nuclear power and proliferation concerns. For the purposes of the PIR readership, the report was excerpted to focus on the nonproliferation aspects of the study. An unabridged version of the text is available online at <http://web.mit.edu/nuclearpower/>.

The generation of electricity from fossil fuels, notably natural gas and coal, is a major and growing contributor to the emission of carbon dioxide – a greenhouse gas that contributes significantly to global warming. We share the scientific consensus that these emissions must be reduced and believe that the U.S. will eventually join with other nations in the effort to do so.

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Better Active Today than Radioactive Tomorrow:

A Review of *Toward nuclear abolition: A history of the world nuclear disarmament movement, 1971 to the present*. This volume is the third in Lawrence Wittner's series *The Struggle Against the Bomb*, published by Stanford University Press, 2003.

By Frank N. von Hippel

In the preface of this third volume of his monumental history, Wittner notes that:

"Again and again, government officials have told us how

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About FAS

The Federation of American Scientists (FAS), founded October 31, 1945 as the Federation of Atomic Scientists by Manhattan Project scientists, works to ensure that advances in science are used to build a secure, rewarding, environmentally sustainable future for all people by conducting research and advocacy on science public policy issues. Current weapons nonproliferation issues range from nuclear disarmament to biological and chemical weapons control to monitoring conventional arms sales and space policy. FAS also promotes learning technologies and limits on government secrecy. FAS is a tax-exempt, tax-deductible 501(c)3 organization.

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At least for the next few decades, there are only a few realistic options for reducing carbon dioxide emissions from electricity generation: increase efficiency in electricity generation and use; expand use of renewable energy sources such as wind, solar, biomass, and geothermal; capture carbon dioxide emissions at fossil-fueled (especially coal) electric generating plants and permanently sequester the carbon; and increase use of nuclear power.

In our view, it is likely that we shall need all of these options and accordingly it would be a mistake at this time to exclude any of these four options from an overall carbon emissions management strategy. Rather we seek to explore and evaluate actions that could be taken to maintain nuclear power as one of the significant options for meeting future world energy needs at low cost and in an environmentally acceptable manner.

The limited prospects for nuclear power today are attributable, ultimately, to four unresolved problems:

- **Costs:** *In deregulated markets, nuclear power is not now cost competitive with coal and natural gas.* ...
- **Safety:** *nuclear power has perceived adverse safety, environmental, and health effects, heightened by the 1979 Three Mile Island and 1986 Chernobyl reactor accidents, but also by accidents at fuel cycle facilities in the United States, Russia, and Japan.*

There is also growing concern about the safe and secure transportation of nuclear materials and the security of nuclear facilities from terrorist attack;

- **Proliferation:** *nuclear power entails potential security risks, notably the possible misuse of commercial or associated nuclear facilities and operations to acquire technology or materials as a precursor to the acquisition of a nuclear weapons capability.* ...
- **Waste:** *nuclear power has unresolved challenges in long-term management of radioactive wastes.* The United States and other countries have yet to implement final disposition of spent fuel or high level radioactive waste streams created at various stages of the nuclear fuel cycle. ...

Global Growth Scenario

To preserve the nuclear option for the future requires overcoming the four challenges described above—costs, safety, proliferation, and wastes. These challenges will escalate if a significant number of new nuclear generating plants are built in a growing number of countries. The effort to overcome these challenges, however, is justified only if nuclear power can potentially contribute significantly to reducing global warming, which entails major expansion of nuclear power. In effect, preserving the nuclear option for the future means planning for growth, as well as for a future in which nuclear energy is a

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competitive, safer, and more secure source of power.

Our study postulates a *global growth scenario* that by mid-century would see 1000 to 1500 reactors of 1000 megawatt-electric (MWe) capacity each deployed worldwide, compared to a capacity equivalent to 366 such reactors now in service. Nuclear power expansion on this scale requires U.S. leadership, continued commitment by Japan, Korea, and Taiwan, a renewal of European activity, and wider deployment of nuclear power around the world. An illustrative deployment of 1000 reactors, each 1000 MWe in size, under this scenario is given in following table.

REGION	PROJECTED 2050 GWe CAPACITY	NUCLEAR ELECTRICITY MARKET SHARE	
		2000	2050
Total World	1,000	17%	19%
Developed world	625	23%	29%
U.S.	300		
Europe & Canada	210		
Developed East Asia	115		
FSU	50	16%	23%
Developing world	325	2%	11%
China, India, Pakistan	200		
Indonesia, Brazil, Mexico	75		
Other developing countries	50		

Projected capacity comes from the global electricity demand scenario in Appendix 2, which entails growth in global electricity consumption from 13.6 to 38.7 trillion kWhrs from 2000 to 2050 (2.1% annual growth). The market share in 2050 is predicated on 85% capacity factor for nuclear power reactors. Note that China, India, and Pakistan are nuclear weapons capable states. Other developing countries includes as leading contributors Iran, South Africa, Egypt, Thailand, Philippines, and Vietnam.

Economics

A major expansion of nuclear power on the scale of this global growth scenario will require government actions that improve the economic viability of nuclear power.

The carbon-free nature of nuclear power argues for government action to encourage maintenance of the nuclear option, particularly in light of the regulatory uncertainties facing the use of nuclear power and the unwillingness of investors to bear the risk of introducing a new generation of nuclear facilities with their high capital costs. ... We recommend that the government provide a modest subsidy for a small set of "first mover" commercial

nuclear plants to demonstrate cost and regulatory feasibility in the form of a production tax credit.

We propose a tax credit of up to \$200 per kWe of the construction cost of up to 10 "first mover" plants. This benefit might be paid out at about 1.7 cents per kWe-hr, over the first year and a half of full-power plant operation. We prefer the production tax credit mechanism because it offers the greatest incentive for projects to be completed and because it can be extended to other carbon free electricity technologies, for example renewablesⁱ, and coal with carbon capture and sequestration.

Nonproliferation

In addition to economic concerns, the challenges posed by proliferation risks must also be addressed. The expansion of nuclear power should not proceed under the global growth scenario

described above, or any other, unless the risk of proliferation from operation of the commercial fuel cycle is made acceptably small. We must prevent the acquisition of weapons-usable material, either by diversion (in the case of plutonium) or by misuse of fuel cycle facilities (including related facilities, such as research reactors or hot cells) and control, to the extent possible, the know-how about how to produce and process either HEU (enrichment technology) or plutonium.

This proliferation concern has led, over the last half century, to an elaborate set of international institutions and agreements, none of which have proved entirely satisfactory. The Nuclear Nonproliferation Treaty (NPT) is the foundation of the control regime, since it embodies the renunciation of nuclear weapons by all signatories except for the declared nuclear weapons states – the P-5 (the United States, Russia, the United Kingdom, France, China) — and a commitment to collaborate on developing peaceful uses of nuclear energy. However, non-signatories India and Pakistan tested nuclear weapons in 1998, and signatories, such as South Africa and North Korea, have admitted to making nuclear weapons.

The International Atomic Energy Agency (IAEA) has responsibility for verifying NPT compliance with respect to fuel cycle facilities through its negotiated safeguards agreements with NPT signatories. The IAEA's safeguard efforts, however, are seriously constrained

by the scope of their authorities (as evidenced in Iraq, Iran, and North Korea during the last decade), by their allocation of resources, and by the growing divergence between responsibilities and funding. ... A variety of multilateral agreements, such as the Nuclear Supplier Group guidelines for export control, aim to restrict the spread of proliferation-enabling nuclear and dual-use technology. European centrifuge enrichment technology, however, is known to have contributed to weapons development elsewhere, and the US and Russia have a continuing dispute over transfer of Russian fuel cycle technologies to Iran (an NPT signatory)ⁱⁱ. The safeguards regime has not failed to restrain the spread of nuclear weapons, but its shortcomings raise significant questions about a global growth scenario that envisions a major increase in the scale and geographical distribution of nuclear power.

In addition to the risk of nuclear weapons capability spreading to other nations, the threat of acquisition of a crude nuclear explosive by a sub-national group has arisen in the aftermath of the September 11, 2001 terrorist attacks. Terrorist or organized crime groups are not expected to be able to produce nuclear weapons material themselves; the concern is their direct acquisition of nuclear materials by theft or through a state sponsor. This places the spotlight on the PUREX/MOX fuel cycle as currently practiced in several countries, since the fuel cycle produces during conventional operation nuclear material that is easily made usable for a weapon.

It is useful to set a scale for the proliferation risk that has emerged from nuclear power operation to date. Spent fuel discharged from power reactors worldwide contains well over 1000 tonnes of plutonium. While the plutonium is protected by the intense radioactivity of the spent fuel, the PUREX chemical process most commonly used to separate the plutonium with high purity, is well known and described in the open literature. With modest nuclear infrastructure, any nation could carry out the separation at the scale needed to acquire material for several weapons. Further, the MOX fuel cycle has led to an accumulation of about 200 tonnes of separated plutonium in several European countries, Russia and Japan. This is equivalent to 25,000 weapons using the IAEA definition of 8 kg/weapon. Separated plutonium is especially attractive for theft or diversion and is fairly easily convertible to weapons use, including by those sub-national groups that have significant technical and financial resources.

The nonproliferation issues arising from the global growth scenario are brought into sharp focus by examining a plausible scenario for the deployment of 1000 GWe nuclear capacity. An important characteristic of this scenario is that much of the deployment would be expected in industrialized countries that either already have nuclear weapons, thus making materials security against theft the principal issue, or are viewed today as minimal proliferation risks. The concern about these nations' ability to provide security for nuclear material is especially elevated for

Russia, whose economic difficulties have limited its effort to adopt strong material security measures; the concern applies to materials from both the weapons program and the fuel cycle, which have significant inventories of separated Pu. Moreover geopolitical change, for example, in East Asia, could change the interests of some nations in acquiring nuclear capability. Japan, South Korea, and Taiwan have advanced nuclear technology infrastructures and over several decades might adjust to the emergence of China as both a nuclear weapons state and a regionally dominant economic force by seeking nuclear capability. North Korea provides a further complication to this dynamic.

The developing world might plausibly account for about a third of deployed nuclear power in the mid-century scenario. An appreciable part of this will likely be in China and India, which already have nuclear weapons and dedicated stockpile facilities and thus are not viewed as the highest risks for fuel cycle diversion. Nevertheless, dramatic growth of nuclear power in the sub-continent could be a pathway for nuclear arsenal expansion in India and Pakistan. The security of their nuclear enterprises remains of concern.

On the other hand, a number of other nations with relatively little nuclear infrastructure today, such as the Southeast Asian countries Indonesia, Philippines, Vietnam, and Thailand are also likely candidates for nuclear power in the global growth scenario. Iran is

actively pursuing nuclear power, with Russian assistance, even though it has vast unexploited reserves of natural gas and could clearly meet its electricity needs more economically and rapidly by using this domestic resource. The United States in particular has argued that this indicates Iranian interest in acquiring a nuclear weapons capability, even though Iran is an NPT signatory and has a safeguards agreement with the IAEA in place. Recent revelation of the spread of clandestine centrifuge enrichment and heavy water technology exacerbates this concern^{iv}.

The rapid global spread of industrial capacity (such as chemicals, robotic manufacturing) and of new technologies (such as advanced materials, computer-based design and simulation tools, medical isotope separation) will increasingly facilitate proliferation in developing countries that have nuclear weapons ambitions. A fuel cycle infrastructure makes easier both the activity itself and the disguising of this activity. Indeed, even an extensive nuclear fuel cycle RD&D program and associated facilities could open up significant proliferation pathways well before commercial deployment of new technologies.

In order to manage the proliferation pathways opened up by the spread of fuel cycle infrastructure, we suggest the following changes to the NPT. The underlying basis of the NPT/Atoms for Peace framework and treaty structure is to permit all countries to have access to nuclear electricity production

benefits and to support nuclear technologies, while implementing IAEA safeguards agreements to avoid the proliferation risk of supporting fuel cycle facilities (both enrichment and reprocessing) that can produce weapons-usable material. We suggest a new approach that centers on classifying states as "privileged" of nuclear reactors or as "fuel cycle states." Declared "privileged states" would operate nuclear reactors according to their internal economic decisions about nuclear power versus alternatives, with international support for reactor construction, operational training and technical assistance, lifetime fresh fuel, and removal of spent fuel. Privileged states would not be eligible for fuel cycle assistance (enrichment, fuel fabrication, reprocessing). On the other hand, the "fuel cycle states" would be subject to a new level of safeguards and security requirements, along the line of those recommended above. Both groups of states would be subject to the Additional Protocol with respect to undeclared facilities. Such an arrangement is a technology- and risk-based approach in the spirit of Article IV of the NPT, offering considerable benefits for those who restrict their nuclear activities while benefiting from

nuclear power".
...
We conclude that the current non-proliferation regime must be strengthened by both technical and institutional measures with particular attention to the connection between fuel cycle technology and safeguardability.
...

Fuel Cycle Choices

The specific technical and institutional measures called for will depend upon the fuel cycle technologies that account for growth in the global growth scenario. We have considered several representative fuel cycles: light water reactors and more

The three representative nuclear fuel cycle deployments examined in this study:

- *Conventional thermal reactors operating in a "once through" mode, in which discharged spent fuel is sent directly to disposal;*
- *Thermal reactors with reprocessing in a "closed" fuel cycle, which means that waste products are separated from unused fissionable material that is re-cycled as fuel into reactors. This includes the fuel cycle currently used in some countries in which plutonium is separated from spent fuel, fabricated into a mixed plutonium and uranium oxide fuel, and recycled to reactors for one pass. This fuel cycle is known as Plutonium Recycle Mixed Oxide, or PUREX/MOX.*
- *Fast reactors^v with reprocessing in a balanced "closed" fuel cycle, which means thermal reactors operated world-wide in "once-through" mode and a balanced number of fast reactors that destroy the actinides separated from thermal reactor spent fuel. The fast reactors, reprocessing, and fuel fabrication facilities would be co-located in secure nuclear energy "parks" in industrial countries.*

advanced thermal reactors and associated fuel forms, operated in an open, once-through fuel cycle; closed cycle with Pu recycling in the PUREX/MOX fuel cycle; and closed fuel cycles based on fast reactors and actinide burning (See Box).

The priority concern is accounting and control of weapon-usable material during normal operation and detection/prevention of process modification or diversion to produce or acquire such material^{vii}.

The open fuel cycles seek to avoid the proliferation risk of separated plutonium by requiring that the highly radioactive spent fuel be accounted for until final disposition. This defines the baseline for adequate proliferation resistance, assuming that spent fuel is emplaced in a geological repository less than a century or so following irradiation (i.e., before the self protection barrier is lowered excessively). However, the open fuel cycle typically requires enriched uranium fuel, so the spread of enrichment technology remains a concern.

The advanced closed fuel cycles that keep the plutonium associated with some fission products and/or minor actinides also avoid "directly usable" weapons material in normal operation, since there is a chemical separation barrier analogous to that which exists with spent fuel. Nevertheless, closed fuel cycles need strong process safeguards against misuse or diversion. However, the development and eventual deployment of closed fuel cycles in non-nuclear weapons states is a particular risk both from

the viewpoint of detecting misuse of fuel cycle facilities, and spreading practical know-how in actinide science and engineering.

...

Proliferation concerns contributed significantly to our conclusion that the open, once-through fuel cycle best meets the global growth scenario objectives, since no fissile material easily usable in a nuclear weapon appears during normal operation, and the "back end" does not have plutonium separation facilities. Enrichment facilities that could be employed for HEU production represent a risk. A variety of measures can minimize the risk: strengthened IAEA technical means to monitor material flows and assays at declared facilities; reliable supply of fresh fuel (and perhaps return of spent fuel) from a relatively small set of suppliers under appropriate safeguards; implementation of IAEA prerogatives with respect to undeclared facilities (the "Additional Protocol"); strengthened export controls on enrichment technologies and associated dual-use technologies; and utilization of national intelligence means and appropriate information sharing with respect to clandestine facility construction and operation.

This is a demanding agenda, both diplomatically and in its resource needs, and calls for active effort on the part of the U.S. and other leading nuclear countries. With such an effort, the level of proliferation risk inherent in the possible expansion to 1000 GWe nuclear power by mid-century appears to us to be manageable.

It is clear that international RD&D on

closed fuel cycles will continue and indeed grow over the next years, with or without U.S. participation. We believe that such work should be restricted by proliferation considerations to those fuel cycles that do not produce "direct use" nuclear materials in their operation.

...

Today, the international discussions are carried out by those principally interested in developing advanced technologies, without the needed level of engagement from those whose primary responsibility is nonproliferation. The U.S. could play a crucial role in shaping these discussions properly before major efforts are underway.

In this context, the PUREX/MOX fuel cycle is a major issue. It is the current candidate, because of experience, for near-term deployment in nations determined to pursue closed fuel cycles. However, it should be stressed that the PUREX/MOX fuel cycle is not on the "technology pathway" to the advanced fuel cycles discussed earlier (typically, the advanced fuel cycles will involve different separations technology, fuel form, and reactor). The U.S. should work with France, Britain, Russia, Japan, and others to constrain more widespread deployment of this fuel cycle, while recognizing that development of more proliferation-resistant closed fuel cycle technologies is widely viewed as a legitimate aspiration for the distant future.

...

In summary, the global growth scenario built primarily upon the once-through thermal reactor fuel cycle would sustain an acceptable

level of proliferation resistance if combined with strong safeguards and security measures and timely implementation of long term geological isolation. The PUREX/MOX fuel cycle produces separated plutonium and, given the absence of compelling reasons for its pursuit, should be strongly discouraged in the growth scenario on nonproliferation grounds. Advanced fuel cycles may achieve a reasonable degree of proliferation resistance, but their development needs constant and careful evaluation so as to minimize risk. The somewhat frayed nonproliferation regime will require serious reexamination and strengthening to face the challenge of the global growth scenario, recognizing that fuel cycle associated proliferation would greatly reduce the attraction of expanded nuclear power as an option for addressing global energy and environmental challenges.

Authors' note: Dr. John Deutch is Institute Professor of Chemistry at MIT and Dr. Ernest J. Moniz is a Professor of Physics and the Director of Energy Studies at the Laboratory for Energy and the Environment at MIT.

ⁱ Wind currently enjoys a 1.7 cents per kWe-hr tax credit for ten years.

ⁱⁱ Since the publication of this report, further developments in Iran have occurred. The IAEA is currently investigating Iran for illicit manufacture of weapons grade highly enriched uranium in violation of its obligations as an NPT signatory.

ⁱⁱⁱ DOE's Nonproliferation Programs with Russia, Howard Baker and Lloyd Cutler,

co-chairs, Secretary of Energy Advisory Board report, January 2001;"Controlling Nuclear Warheads and Material", M. Bunn, M. Wier, and J. Holdren, Nuclear Threat Initiative report, March 2003.

^{iv} See note ii.

^v Many of these elements (fresh fuel supply, spent fuel return, reactor construction assistance, Additional Protocol) have been discussed intensively over several years between the United States and Russia as a means of resolving differences with respect to Russian-Iran nuclear cooperation.

^{vi} A fast reactor more readily breeds fissionable isotopes potential fuel-because it utilizes higher energy neutrons that in turn create more neutrons when absorbed by fertile elements, e.g. fissile Pu239 is bred from neutron absorption of U238 followed by beta (electron) emission from the nucleus.

^{vii} E. Arthur, et. al., "Uranium enrichment technologies: workshop materials," Los Alamos Report — LA-CP-03-0233, (December, 2002).

A Place to Work Together

Keynote Address by Michael Douglas

Editor's note: Michael Douglas delivered the following speech as part of a briefing made to the US Congress on October 2, 2003. The session was entitled "The Limits of Unilateralism" and was hosted by the House of Representatives Bipartisan Task Force on Non-Proliferation in cooperation with the Bipartisan Security Group, a program of the Global Security Institute. The Bipartisan Task Force holds regular briefings for interested Members of Congress, their staffs, the press and the public. This session was one of a series.

It is a great honor to be here with you, especially because of the example set by the Bipartisan Task Force on Nonproliferation and its co chairs Congressman Chris Shays and Ed Markey. I would also like to thank the Bipartisan Security Group, and its group of experts like its Chairman Ambassador Thomas Graham, and my friend Jonathan Granoff. I support and applaud your efforts.

A wise person recently pointed out that no one has ever washed a rental car. Why bother if you don't own it? When people are engaged in a process, they are far more likely to support its outcome. Nations behave the same way.

In 1945, the United Nations was founded with one major goal in mind, and I quote, "to save succeeding generations from the scourge of war." The founders

noted that twice in the 20th Century major wars had brought "untold sorrow to mankind." Since its founding, 191 nations have joined the UN.



Michael Douglas (r) and FAS's Benn Tannenbaum after Mr. Douglas's well received speech to the House Bipartisan Task Force on Nonproliferation.

We have no other place where all nations can work together for peace, a place where we can use verbal conflict rather than armed conflict to solve problems. And often, the UN, with US support, has provided armed force to help ensure the peace.

The entire planet now faces global challenges including ensuring bio-diversity and ending the destruction of thousands of species; reversing the depletion of

fishing stocks; controlling ocean dumping; preventing ozone depletion; halting global warming; controlling and eliminating terrorism and weapons of mass destruction; fighting pandemic

diseases; ending the tragedy of crushing poverty and lack of clean drinking water; and addressing crises arising from failed states. No nation or even a small group of nations can succeed in addressing these issues alone.

If the application of solutions appears to be done only through the orders of decision-makers in Washington, DC, in derogation of the UN, the results will be cynicism, lack of cooperation, and ultimately

failure. Failure is not something we can afford.

Working with the UN, I can tell you that America's interests are best served when others want to emulate our good example. America's interests are best served when we act in coordination with other nations, and when we demonstrate our values by our actions. Franklin Roosevelt defined those core values as four freedoms: freedom of speech and expression, freedom of every person to worship God in their own way, freedom from want, and freedom from fear.

That is the America the world has come to love.

The United Nations is based on political insights that have led to successful governance principles and enhanced the wealth of nations. These values include market freedoms, religious liberty, an independent judiciary, government transparency and accountability, democracy, and a high level of respect for civil liberties and human rights.

They have evolved into nearly universal goals and norms. The countries that have adhered to these principles are the most secure and healthy.

The United Nations is guided by such countries, and simultaneously provides the only viable forum for the expression of the aspirations of the poor and the weak.

The establishment of international norms of conduct is where idealism informs realism. These powerful principles are not mere

abstractions. Recently, I visited Sierra Leone, where I saw the consequences of failure to abide by these norms: child soldiers; severed limbs; disrupted lives; suffering beyond words. Global issues distill to the particulars of individual lives. Our capacity and responsibility to enhance so many individual lives should not be taken lightly. We are called to nothing less than moral leadership.

When moral leadership is coupled with power, it galvanizes the world. Moral leadership requires living up to one's promises and commitments.

Fulfilling our promises in the Nuclear Nonproliferation Treaty, now with 188 member States, must be a primary aim. This Treaty, essential to our security, will be reviewed formally in 2005 at the UN.

At the 2000 Review of the Treaty, the US along with all other parties to the Treaty made a pledge. Let me remind you of what was promised, and I quote: "an unequivocal undertaking by the nuclear weapons states to accomplish the total elimination of their nuclear arsenals... leading to nuclear disarmament..."

There are tens of thousands of nuclear weapons in the world, over 90% are possessed by Russia and the US. Most are many times more devastating than those used on Hiroshima. The arsenals of Russia and the US are armed, targeted and poised, waiting for three short computer signals to fire. These hair trigger devices represent the devastation of approximately 100,000 Hiroshimas and pose a horrific threat to life. The use of a

nuclear weapon could take place by accident or design by states, or even terrorists. These weapons pose an unacceptable risk to the planet.

We must demonstrate our unambiguous commitment to fulfill our promises. Otherwise, the prospect of more nuclear-weapons states, and the construction of new nuclear weapons, will only increase human peril. The world needs a more effective nonproliferation and disarmament regime and is looking to us for leadership.

The drafters of the United Nations Charter created a harmonious system that permits dynamic and broad engagement through the General Assembly, the Security Council, numerous agencies and the Secretariat. The present situation in Iraq presents us with the opportunity to re-affirm our commitment to the principles that guide the UN. Regarding the reconstruction of Iraq, it has become clear that there is no substitute for UN cooperation for legitimacy and effectiveness.

Additionally, we should support Secretary General Kofi Annan's call for reform and strengthening of the UN system. This is the best way to satisfy all the members of the international community, demonstrate American leadership, and make our world more secure.

America can be proud when we lead by inspiration rather than by coercion. America can be proud to have proven that the human condition is advanced when power is shared. It is an affirmation of faith that the inefficiencies of discussion

Taiwan Pins Hope on Science

By Henry Kelly

Editor's Note: On November 12-17, 2003, Henry Kelly attended the 24th Science and Technology Advisory Group (STAG) Board meeting of the Taiwan Executive Cabinet. He was invited to serve as a guest Advisor at the meeting, which was convened by the Premier to coordinate local industry, government, academia and research institutes to address Science and Technology issues. Kelly opened the second day of the meeting, dedicated to Sustainable Development and Industry Policy, with a keynote speech entitled, "Policies that Drive Sustainable Economic Growth." Below are some of his observations from the trip.

Traveling in Taiwan with **Yuan Tseh Lee**, Nobel laureate in Chemistry and President of the Academia Sinica, is like touring the US with a rock star. People stop him on the sidewalk to ask to be photographed with him and rush into restaurants to shake his hand. We walked into a small shop in a remote village and a passing college student who spotted him returned quickly with ten friends to ask for a group picture. He always graciously complied.

Lee's treatment is well deserved – he's a brilliant, thoughtful and generous man who has made enormous contributions to world science and to Taiwan. But it also reflects a strong consensus that technology has been good to Taiwan and remains the undisputed hope for its future – a belief that has endured through the rough economic times of the past few

years. The power of this idea is certainly reflected in their passion for education – much of it in technical subjects. It seems that everyone is in school or planning to take an evening course to bone up for a new job. When I asked why the subways in Taipei were crammed at 8pm, there was universal agreement that the crowd resulted from people rushing from offices to night courses. In fact a quarter of the entire population is enrolled in an educational institution at any given time. Nearly half the high school graduates go on to college.

I received an intense, if brief, view of all of this in a few days of reviewing the government's new science and technology plans as a foreign member of the Science and Technology Advisory Group – STAG (yes, they could use some acronym counseling). After coping with Washington where it takes a heroic effort to generate excitement about any research not directly related to security, it was delightful to participate in a serious discussion of how science and technology policy could contribute to economic and social goals. This doesn't mean that the military is being shortchanged; Taiwan spends a higher fraction of its GDP on defense than any European nation.

The Taiwanese proposals we were asked to review were obviously the result of considerable effort and reflection. And they were of great

interest to the highest levels of government. We met privately with Premier Yu Shyi-kun who asked unrehearsed, probing questions of the participants and went on to deliver a passionate public address on the subject. He spoke extemporaneously for at least 15 minutes on the need to use scientific research to find ways to build a Taiwan that is economically successful and at the same time preserves and celebrates the beauty of its natural environment. In a nation bristling with some of the world's most aggressive business managers, it was delightful to find a leader convinced that given good government, well managed collective action to preserve environmental quality could be completely compatible with rapid economic growth. The most contentious environmental issues are: (1) the completion of the fourth nuclear plant – the current government is backing away from a commitment to stop construction – and (2) aggressive, some would say pork-barrel, road building – they seem to suffer from the Japanese illness.

The planners focused on three central questions: (1) how to shift Taiwan from a highly successful imitator to an innovator – including an ability to innovate in the delivery of services; (2) how to use science and technology to meet domestic and international obligations to achieve a "sustainable economy" and (3) how best to prepare for a

fortunate we have been to have benefited from their wise leadership... Paradoxically, they argue, it has been their willingness to develop, deploy, and use nuclear weapons that has limited the nuclear arms race and averted nuclear war."

His book tells another story,

"of how concerned citizens around the world --through intelligence, courage, and determination--have altered the course of history..."

The story is of a vast movement of hundreds of organizations becoming more -- and then less -- politically active and effective in synchrony around the world ¹.

The book opens with the ending of the Vietnam War, which allowed an aroused global peace movement and the new anti-nuclear-power movement to join in opposition to the US-Soviet arms race. Following the election of Jimmy Carter as President in 1976, this movement won two early victories with the US decisions to abandon the neutron bomb and the B-1 bomber. US and Soviet hawks prevailed later in the Carter Administration, however, with US decisions to deploy new nuclear missiles and Moscow's invasion of Afghanistan in 1979.

Thing got worse after Ronald Reagan was elected President in 1980. He brought with him into the Executive Branch a galaxy of nuclear hawks, including some who believed it possible to fight and win a nuclear war. These ideologues

sometimes even frightened the President and his wife. They certainly frightened Moscow, which launched its biggest-ever peacetime intelligence operation to detect US preparations for a first strike. Most importantly for this story, they frightened the public.

The result was an enormous growth of the anti-nuclear-weapon movements in the US and Europe, Japan, Canada, Australia and New Zealand. These movements fielded demonstrations so huge and were backed by so much of the public that they could not be ignored. They included a multi-year siege by thousands of British women of the proposed US cruise missile base at Greenham Common and a million-person demonstration in Central Park on June 12, 1982.

In the US, the movement coalesced around a call for a bilateral "freeze" of the nuclear arms race. Despite vicious attacks by the Reagan Administration, which claimed that the Kremlin was behind the movement, this call was endorsed in 1982 in referenda in nine out of ten states and 34 out of 37 cities and counties. In Western Europe, the CIA and the US Information Agency backed similar unsuccessful efforts by NATO governments to portray the European Nuclear Disarmament movement as controlled by Moscow while END was, in fact, supporting dissident human-rights groups in Eastern Europe and the Soviet Union.

Soon, according to Richard Allen, Reagan's first national-security advisor, "the President was

swimming upstream, against the current" of public opinion. Congress began to vote against his weapons programs, including the 10-warhead MX missile that he had dubbed the "Peacekeeper," and NATO allies in Europe began to balk at hosting new US nuclear-armed ballistic and cruise missiles. To the disgust of some of the hawks in his administration, Reagan responded to this political pressure by making arms control proposals that were more and more negotiable and began reciting the mantra, "a nuclear war cannot be won and must never be fought."

After Mikhail Gorbachev became Secretary General of the Soviet Communist Party in the spring of 1985, his unilateral initiatives, including a nuclear testing moratorium and the withdrawal of 10,000 tanks from Europe, resonated with aroused Western public opinion and persuaded President Reagan to join in ending the Cold War. Gorbachev, for his part, acknowledged that his "new thinking" was heavily influenced by the proposals of the foreign peace movement and especially "the joint efforts of Soviet and American scientists."

The FAS contributed significantly during this period. In 1983, FAS officials and staff began to meet with the new Committee of Soviet Scientists (CSS) led by Evgeny Velikhov. After Gorbachev came to power in the spring of 1985, we learned that we had been brainstorming with one of Gorbachev's key advisors. Velikhov promoted Gorbachev's 1985-87 unilateral nuclear test moratorium

and obtained permission for the Natural Resources Defense Council (NRDC) to install seismometers around the Soviet test site – the first time that the previously paranoid Soviet leadership had accepted in-country verification. Starting in 1987, the FAS and the CSS carried out a joint study showing how warhead elimination could be verified without revealing design secrets. This laid the basis for another remarkable cooperative project in the summer of 1989, when Velikhov and the NRDC co-organized a demonstration of the detectability of a nuclear-armed cruise missile on a cruiser in the Black Sea off Yalta.

When George Bush Sr. became president, he tried to put the brakes on what he felt had become an excessively soft Reagan Administration policy toward the Soviet Union. But, before long, he found himself under enormous pressure from the NATO allies and Congress to continue the work of dismantling the nuclear confrontation. He complained to Scowcroft that he was "sick and tired of getting beat up day after day for having no vision and letting Gorbachev run the show." Robert Blackwill, the National Security Council official responsible for Europe and the Soviet Union complained about "the wild beast of public opinion."

In 1991, Bush and Gorbachev signed the START I Treaty. More dramatically, that same year, after US proposals to modernize its short-range nuclear weapons in Europe were rebuffed by its NATO allies and the Soviet Union began to

disintegrate, President Bush initiated the reciprocal unilateral denuclearization of the US and Soviet armies and the removal of nuclear weapons from surface ships. Finally, on the eve of the 1992 election, he reluctantly signed a law that ended US nuclear testing -- as long as other countries did as well.²

With the end of Cold War, however, the public assumed that the nuclear danger was over and turned to other concerns. Within a few years, the nuclear bureaucracy felt free to suspend the dismantling of the Cold War Doomsday Machine. Few know that the US still has approximately 2000 nuclear warheads ready to launch at Russia within 15 minutes and that Russia is believed to maintain a similar posture. In 1994, the Department of Defense (DoD) also decided to stop destroying most strategic warheads being removed from deployment so that US-Russian nuclear reductions agreements could be quickly reversed if Russia reverted to hostility or China launched a major nuclear buildup. The Senate's Republican leadership similarly felt free to resume its anti-arms-control posture and rejected the Comprehensive Test Ban Treaty in 1999.

When George Bush Jr. took over the Presidency in 2001, he brought with him a foreign policy team with beliefs very similar to the Reagan team of 20 years earlier. The Congressionally created Rumsfeld Commission had already generated a nuclear-missile threat from the "Axis of Evil" nations to replace the

threat from the "Evil Empire." This threat provided the basis for a quick renunciation of the ABM Treaty that had blocked President Reagan's beloved Strategic Defense Initiative. Even before ground was broken for the first missile interceptor in Alaska, the DoD claimed that Russia's hair-trigger missile posture no longer represented a threat because US policy now "provides missile defense to protect the United States, its allies, and friends against limited or unauthorized launches." The DoD also began promoting the need for new nuclear weapons -- especially high-yield nuclear explosives in earth-penetrating shells "to deny the enemy sanctuary in hard and deeply buried targets."³

Nuclear weapons were first used 58 years ago with results so horrific that they have not been used since. Wittner quotes thirty years of polls in many countries showing overwhelming public rejection of nuclear weapons. But it also shows that "responsible" government bureaucracies ignore this deep anti-nuclear-weapons sentiment when it is not politically mobilized.

This book is a timely reminder as we begin a new election season in the US.

Author's Note:

Frank von Hippel is the former Chairman of FAS and Professor of Public and International Affairs, Princeton University.

¹ FAS members should be aware also of three other books that focus specifically on the history of the scientists' anti-nuclear-weapons movement: *A peril and a hope: the scientists' movement in America, 1945-47* by Alice Kimball Smith (Chicago

University Press, 1967; MIT Press, 1971) which includes an account of the founding of the Federation of American Scientists; *American science in an age of anxiety: scientists, anticommunism & the Cold War* by Jessica Wang (University of North Carolina Press, 1999) which describes how this activism was partially quelled during the McCarthy era; and *Unarmed forces: the transnational movement to end the Cold War* by Matthew Evangelista (Cornell University Press, 1999) which includes an account of the Pugwash movement and FAS contributions during

the Gorbachev era.

² The Hatfield-Mitchel-Exon amendment that forced the US test moratorium went into effect at the end of September 1996 but was one of the casualties of the May 1998 Indian and Pakistani nuclear tests.

³ Quotes from the leaked report of the DoD's 2001 Nuclear Posture Review, <http://www.globalsecurity.org/wmd/library/policy/dod/npr.htm>.

Field Workshop on Degraded Lands for Chinese Environmental NGOs

(Non-Governmental Organizations) November 10-16, 2003

By Walter E. Parham

Preliminary Summary

An interdisciplinary group of about 40 Chinese natural resource scientists and Chinese environmental NGO representatives from 17 of China's 26 provinces and municipalities, participated in a degraded-lands field workshop in Guangdong Province. Ten faculty and graduate students from the South China Agricultural University (SCAU) in Guangzhou participated. The workshop, the first of its kind, was sponsored jointly by FAS and SCAU and supported by The International Foundation (U.S.), and the Guangdong Natural Science Foundation (China). The objectives of the field workshop were (a) to strengthen communications between environmental non-governmental organizations and the science community in dealing with degraded land problems, (b) to high-light degraded land problems in South China, (c) to identify causes of land degradation, (d) to

illustrate various sustainable solutions to improve degraded lands, and (e) to assess any adverse, unexpected effects from implementing solutions.

— During five days in the field, the workshop participants visited 15 sites including Dinghushan, a Man and the Biosphere Reserve (MAB), one of the last mountainous remnants of South China's native tropical, broad-leaf monsoon forest about 4.5 square miles in size; Heshan Research Station to see stereoagriculture (agriculture that varies with topographic position) and tropical forest research; the 1300 square miles of litchi/longan orchards in western Guangdong; the start of a ten square mile, fast-growing eucalyptus plantation for paper production; a tangerine plantation using chickens for biological pest control; a factory for production of tangerine-based Chinese medicine; Xiaoliang Soil and Water Conservation Station's demonstrations of the recovery of

extensive, severely degraded lands; restoration of a six square mile oil-shale tailings site 150 feet thick; and island mangrove restoration in the Pearl River from 75 acres to 2 square miles.

— Observations of Guangdong Province during the fieldtrip include: broad evidence of rapid economic development; expanded tourist activities within natural reserves and state farms; improved highways with growing automobile and truck traffic and traffic jams; numerous, large, active and abandoned quarries in the granite hillsides; numerous brick factories in urban and rural areas; rapid expansion of fruit production throughout the province; continued use of medical wastes as fertilizer in some litchi/longan orchards; continued expansion of tree plantings with non-native species of eucalyptus, casuarina, and pine; and the extensive use of firewood in the villages and countryside.

— Thinking back over visits to this region of ten or so years ago, it is clear that there is a significant increase in the amount of a green vegetative cover on the land today. Nevertheless, however green the land surface may be today, it seems largely the result of an "agricultural production" thinking rather than thinking fostering an "agroecological" approach.

— Evidence of increased tourism exists in natural reserves and state farms. Because the government has withdrawn support from many previously state-run operations, tourism activities probably are helping to offset the operations' reduced incomes. For example, the Dinghushan MAB reserve is under pressure from the local government to continue to open new areas of the reserve to money-making activities related to tourism. Here, an artificial lake was constructed for house-boat use and for general boating; an island within the lake developed for tourist lodgings;



This photograph of Guandgdond Province near Huazhou shows where a new, large farm is being established on terraced, deeply weathered bedrock. The goal here is to practice intercropping of many different kinds of crops such as hot peppers, tree crops like litchi, persimmon, papaya, rubber, carambola and about 25 other food crops. The tropical monsoon climate here has a six month dry season and a six month rainy season. Adequate water is a problem during the dry season so reservoirs are constructed for use with spray irrigation.

erection of souvenir shops around a newly completed plaza; and giant replicas of ancient Chinese vessels and people. In one state farm for



The above is photo of the Field Workshop. Pictured are Walter E. Parham (middle), the author; Luo Shiming (left), President of the South China Agriculture University, who established the first agroecology program in South China; and Han Hui (right), head of the University's International Affairs.

litchi production, life-size dinosaurs stand between the litchi trees; tourists ride tandem bicycles around man-made lakes and fishing ponds that are in turn surrounded by picnic areas. In another state dairy farm, the original excellent work on sustainable agriculture largely is lost amid such things as pony rides, grass-skiing slopes and fields, and the sale of milk-filled baby bottles for feeding tied up, three-month old calves. Yet, tourism at the Qi'ao Island mangroves clearly is helping in mangrove restoration. Here, restoration income from mangrove boat tours and bird (egret) watching is playing a positive role in providing funds to expand the mangroves.

— Nevertheless, workshop participants' comments indicate that they believed that it was valuable to bring environmental NGOs and natural resource

scientists together to strengthen the knowledge of both groups and that it helped close a communication gap between the groups. The workshop leaders encouraged the environmental NGOs to hold similar workshops in their home areas to help strengthen their arguments for requested government action on environmental issues. It seems clear that most environmental NGOs, though probably under funded, nevertheless are striving to accomplish important conservation goals.

Follow-up Activities

The invited workshop participants were informed on the closing day of the workshop that in six months FAS/SCAU will send each of them a questionnaire asking what accomplishments each has made to develop new activities to improve communications between environmental NGOs and their local scientific community. The focus will be on activities related to improving degraded lands and the sustainable use of the land. Data gathered will be used to help FAS/SCAU evaluate whether or not any long-term benefits had been derived from the environmental NGO workshop. In addition, FAS/SCAU will look for any additional unexpected benefits resulting from the workshop. The information gathered will be assessed and sent to the two institutions that provided funding.

For more information, contact NGO Workshop Director, Walter E. Parham, Ph.D., phone/fax (703) 281-1457, e-mail parham305@aol.com.

possible return of SARS or another unexpected infectious disease.

The economic challenge results from the fact that the Mainland Chinese are beating the Taiwanese at their own game in low-cost manufacturing in electronics and many areas -- in no small part because of capital and expertise provided by aggressive Taiwanese business people. The new national goal is for Taiwan to be at the cutting edge in inventing new products and processes in information technology, biotechnology, nanotechnology and other areas. The clear subtext is a sense that the US is stumbling in its management of innovation, leaving a real opening for Taiwanese innovators. They have a clear shot at the gold ring. The need to build a world class university system in Taiwan was a consistent theme. STAG members Lew Branscomb, Eugene Wang and Ian Ross provided a constructive review of the plans and sounded a strong warning against the temptation to measure the success of university research largely by patent generation or success in solving corporate research problems. They also described the large leap that would be needed for the research program to support innovations in services.

The SARS outbreak that hit Taiwan in the spring of 2003 exposed the weaknesses of Taiwan's infrastructure for dealing with infectious diseases. While the Taiwanese response was certainly better than it was in many other places – and probably on a par with the US –they were very willing to

talk about the painful lessons that had been learned and eager for advice about strengthening the system. The STAG team recommended that Taiwan anchor an Asian Pacific research network in infectious diseases tied to similar efforts in the G-8 and European Union. And they provided practical suggestions for providing much needed training for health workers and for operating an effective early warning and response program. They emphasized the need to exempt professionally credentialed health workers from the civil service examination that is an ancient burden on anyone entering government service.

The sustainable development plans presented by the Taiwanese were extensive and included a detailed discussion of how Taiwan could reduce greenhouse gas emissions as well as plans for restoring degraded lands and cement-lined rivers. The country is building a large, well managed set of national parks and other land protected from damaging forestry and farming practices. The STAG group emphasized the need to build research in many fields into the sustainable development goals and the need to integrate sustainability goals into research and development in a variety of areas – agriculture, new electronic devices (for example, a third of all electronic ballasts are made in Taiwan) and other areas.

I can only hope that the next generation of Taiwanese scientists is as popular on the street as Y.T. Lee. But things look good. The government is committed to a

program that ties many of the nation's aspirations to success in science and technology – a view that seems to be shared by everyone I met. Having released a number of the dead hands that hobbled them in the past, the country seems exhilarated by the opportunities presented by the coming decade and the role science can play in building a better life for themselves. Through their inventions and exports, they're also looking beyond their borders to build a better world community.

Author's Note: Henry Kelly is the President of FAS.

Cooperative Threat Reduction: The View from Washington

By Ivan Oelrich

Editor's note: This paper was presented on the 19th of October, 2003 at the Danish and Norwegian Institutes for International Studies Conference in Copenhagen, as part of a panel discussion entitled "Securing Dangerous Materials in the Former USSR."

When the Soviet Union collapsed, ending the Cold War, the world became a far less dangerous place. But not all the news was good, especially in the short term. Strategic nuclear weapons had been stationed in three Soviet Republics other than Russia – was the world suddenly to have three new nuclear powers with untested civilian and military nuclear control? Tactical nuclear weapons might have been deployed in several other former Soviet Republics. What was to become of them or the chemical and biological weapons formerly under the central control of the Soviet Union?

The United States responded warily to the demise of the Soviet Union, but recognized that it was in its own best interest to help secure dangerous materials in the former Soviet Union. To meet a variety of needs, the United States started an ad hoc combination of assistance programs to the states of the former Soviet Union. These programs are lumped under the name of cooperative threat reduction (CTR), but bureaucratically they remain only loosely coordinated. (Note that "Cooperative Threat Reduction" in capital letters usually refers

specifically to programs funded under the Nunn-Lugar legislation. In this paper, I use the term "cooperative threat reduction" generally. The highly enriched uranium blend-down agreement, for example, is clearly a form of cooperative threat reduction, but is not part of Nunn-Lugar.) This paper does not focus directly on the condition of or the control of dangerous materials in Russia or the former Soviet Union. Instead, it surveys cooperative threat reduction from Washington's perspective, examining some of the political, bureaucratic, and financial constraints.

Both Russia and the United States have made significant accomplishments in securing and destroying dangerous materials and generally reducing the threat of theft of weapons of mass destruction by terrorists. And while the program continues to enjoy support from the US government, the support is neither strong nor deep. The difficulties of the CTR program range from minor to major. The question facing the future of CTR is not whether its problems are insurmountable – they are not – but whether there is the political will to overcome them.

The CTR program is extremely broad. CTR programs help build safer, tamper-proof rail cars to transport Russian nuclear warheads and they also help redesign

Russian nuclear research reactors so they no longer use highly enriched uranium (HEU). The majority of these programs are related directly or indirectly to the destruction, security, or management of dangerous materials or weapons. The few efforts that are not materials related include destruction of bombers and ICBMs along with their silos, closure of nuclear testing tunnels, and alternative research for Russian nuclear scientists.

First and foremost of the cooperative programs is the safeguarding or destruction of assembled nuclear warheads. The United States has worked with the Russians to train security personnel and develop new security equipment. It has also provided the Russians with 123 kilometers of security fencing and other sensors for installation around nuclear weapons storage sites. The Russians have completed the first security upgrades at over 30 sites. The United States has funded secure railcars, designed specifically to transport nuclear warheads between storage sites and to dismantlement sites. The United States offers some assistance to Russia for nuclear warhead dismantlement but, because of the sensitive nature of the work, this support is necessarily limited. Once the material has been removed from warheads, however, the United States again helps with

material disposition. The Mayak Fissile Material Storage Facility will safeguard nuclear material from over 10,000 nuclear warheads. The United States is helping pay for a Mixed-Oxide (MOX) fuel fabrication facility that would convert 34 tons of Russian plutonium into useable nuclear fuel. (The US would also burn up, or otherwise dispose of, another 34 tons of plutonium.) In a separate program, the United States is buying low enriched uranium derived from the blend-down of 500 tons of weapon's grade HEU, which will be burned to produce electricity.

In addition to nuclear weapons and the materials recovered from them, the United States and Russia collaborate on reducing the amounts of weapon-usable fuel in nuclear reactors or otherwise securing the material. The Reduced Enrichment for Research and Test Reactors (RERTR) project is working on developing low enriched fuel, that is, less than 20% U-235, that can replace the HEU in current research reactors. Other programs aim to repatriate HEU from reactors the Russians have sold to foreign countries, and to close the BN-350 breeder reactor in Kazakhstan.

The United States and Russia also collaborate on destroying or securing chemical and biological weapons. These projects are not, in general, as far along as their nuclear materials counterparts, some being in the planning stages. But the United States has assisted Russia in improving perimeter security at former bio-weapons sites in Novosibirsk and Obolensk.

Similarly, the chemical weapons cooperation has focused more on destruction of some chemical weapons facilities and securing others rather than the chemical weapons themselves.

The CTR program has had some notable missteps. The United States has spent over \$200 million on construction of two rocket fuel recycling plants in Votkinsk and Krasnoyarsk that will probably never be used. \$95 million was spent on the solid rocket motor burn facility at Votkinsk when construction stopped because local environmental permits were not forthcoming. The United States had already spent \$106 million on a liquid rocket fuel reprocessing facility in Krasnoyarsk by the time the Russians informed the Americans that the fuel had already been turned over to the civilian space program. In both cases, some blame can be assigned to the US Department of Defense (DoD), but Congress believes the Russians should have been more forthcoming about the needed permits and the disposition of the fuel. The United States understands that both it and Russia have security and economic interests in the CTR programs. The United States also understands that it and Russia will weigh differently the relative importance of security and economy. The US attitude is that this is not a commercial deal, but helpful assistance between nations that share common interests. Caveat emptor does not apply. At the very best, the rocket fuel experience reflects a complete breakdown in communication. At worst, it is possible to believe that

Russian authorities lacked any incentive to remind the Americans of problems as long as US money was flowing into the economy.

Many in the US Congress question the basic premise of CTR efforts. Why, they ask, should the United States pay for a problem that the Soviets/Russians created? In the worst possible case, when the United States helps with tasks that the Russians consider essential, it is freeing up funds that the Russians can devote to strategic weapon improvements. To the extent this is true, it is not clear that CTR efforts, however efficient, provide a net benefit to US security.

Access and transparency are continuing sources of friction between the United States and Russia. The United States wants to ensure that money and equipment go where they are supposed to go and are used properly. The Russians, on the other hand, are concerned about state security and secrecy, and resist intrusive auditing or on-site inspection. The most difficult case is security of nuclear weapons storage facilities. The Americans want to ensure, for example, that security fencing provided to keep intruders out is actually installed at the sites, not diverted to some other use, and are even concerned whether it is installed properly to provide maximum security. The Russians are adamant that even the locations of their nuclear storage sites remain secret and foreigners are not allowed to visit, much less inspect the sites. Similarly, American technicians are not allowed into all buildings at former biological

weapons facilities, which raises serious questions for the Americans. If the Russians have ended biological weapons work, what is the source of their sensitivity?

One immediate challenge facing the CTR program is the unresolved issue of liability. Two programs, the Plutonium Disposition Program and the Nuclear Cities Initiative, are in limbo right now because the United States and Russia cannot reach agreement exempting US firms from legal damages resulting from some mishap during US-funded activities. The US wants these two programs covered by the rules that cover almost all other CTR programs that severely limit US liability. The agreements under which these programs operate have lapsed, although existing work is continuing for a while under a short term extension.

Some Russians complain that, in general, the Americans' attitude is "It's our money, so we make the rules" and are unconcerned about Russian sensitivities. Some Americans feel that the Russians do not take seriously the dangers of material security. Their attitude is "If the Americans are so worried, let them pay for it." If the spirit of cooperation breaks down, then the whole program will fail. Rose Gottemoeller, of the Carnegie Endowment for International Peace, has suggested that a useful American good-faith gesture would be to ignore the direction the money is flowing and offer reciprocal nuclear weapon site inspections to the Russians, thus restoring a symbolic equality

between the parties. Just as importantly, reciprocity would drive home to the Americans exactly how intrusive their requested inspections might be, or seem to be, and might temper US demands. The Russians must accept responsibility for failures as well. Without going into detail, there is a fairly clear pattern that CTR programs with the Russian Navy run more smoothly than with other parts of the Russian government or military. The difference, the "independent variable," is which Russian bureaucracy the Americans are dealing with. This suggests that good relations are possible, but not without cooperation on the Russian side.

Any enterprise as large and complex as US-Russian CTR is bound to have problems. But none of the problems are insurmountable. In a situation like this, the question is whether there is the political will to keep pushing forward in spite of problems, or whether the whole process will come apart because each side feels it is shouldering an unfair share of the burden. From the Washington perspective, support remains, but it should not be taken for granted. And the political and bureaucratic realities work against CTR programs. The basic weakness of CTR is that it lacks a constituency, either politically or bureaucratically.

Officially, the Bush Administration fully supports CTR. But this is a legacy program inherited by the Administration, not something of their creation. Moreover, the Bush Administration has demonstrated that it does not always look first to

treaties or other cooperative approaches when approaching international problems. Within the Administration, responsibility for CTR programs is divided. Those involving nuclear materials and weapons are the responsibility of the Department of Energy. Other weapon programs, for example chemical weapon demilitarization or destruction of nuclear delivery systems, fall under the purview of the Department of Defense. Some smaller programs, for example scientist training and border security, fall under the Department of State. Thus, there is no single bureaucratic entity that is responsible for CTR, no department whose fortune depends on its success.

In Congress, it is the committees that make the real decisions about all but the most politically visible budgets. The committee structure roughly reflects the Administration's department structure. Therefore, just as CTR programs are divided between departments, their Congressional authorization and appropriation fall under several different committees. It is notoriously difficult to get various committees of Congress to coordinate their actions. Again, there is no single champion, either individual or committee in Congress, that is responsible for the CTR effort. We have even lost one sponsor of the CTR, that is, the Nunn-Lugar legislation. Senator Nunn has left the Senate and he was arguably one of the most powerful Senators in recent times.

CTR also suffers from the lack of a natural political constituency in

and debate, of checks and balances, ultimately build better governance than authority centralized in unaccountable hands.

Let America's hands be as open as our hearts. Let America's spirit of cooperation be based on our vision of democracy. Let America engage the international community more deeply, and more formally.

When we have confidence in working together, others will have confidence to work with us. The call based on "we the people" opened

new vistas of government based on principles of participation and inclusion. That call for inclusion was heard around the world when our great nation was born. Less than two centuries later, the resonance of that call helped form the United Nations. We, today's champions of that call, can and must lead with pride. Thank you.

Author's Note: Film and television actor and producer Michael Douglas has demonstrated a strong commitment to disarmament, including nuclear non-proliferation and stemming the tide of small arms and light weapons. Mr. Douglas has promoted abolition of nuclear weapons

as a moral imperative. He has also spoken out in favor of greater controls over the illegal possession and circulation of small arms and light weapons. He has helped promote an innovative UN program of weapons recovery in Albania, encouraging people at the community level voluntarily to return arms in exchange for development assistance. He also recently visited Sierra Leone and filmed a documentary on children soldiers co-produced by RCN Entertainment and the United Nations for Showtime. He was appointed a UN Messenger of Peace in 1998.

Congress. The members of both house of Congress are elected by geographical region, not by party list. Members pay careful attention to the economic interests of their constituents "back home." But CTR funds are spent mostly in Russia and Russians can't vote for the people in Washington who are allocating funds; CTR spending doesn't win votes. Americans are obsessive about government's "wasteful" spending, which often means money spent on someone else, but to waste money on Russians is politically a double blow. The defense industry makes billions of dollars from government contracts and the industry hires small armies of lobbyists to make certain that their concerns are heard in Congress. The CTR effort does not have a comparable powerful industrial interest supporting it.

The CTR programs survive in part because they are a good idea, but also in part because the total amount of money is small

compared to other defense programs. It therefore remains a good "deal" and remains under the political radar. Seen in this light, it might actually be good that CTR does not get a lot of attention. Even if the program is executed flawlessly, it will win its proponents few political rewards and carries the risk of bad publicity, such as another rocket fuel recycling debacle.

No easy solutions present themselves. Good management and good communication are essential. The Russians must share the sense of urgency that the Americans feel about loose nuclear weapons and other dangerous materials. European governments may have a role to play. Cost sharing is welcome as long as it does not complicate the already complicated program administration. Some European countries might offer to act as honest brokers between the United

States and Russia. For example, there are probably retired Soviet military officers from Ukraine, Kazakhstan, or the Baltics who know as much as anyone can know about Russian nuclear storage sites. The Russians might not object on security grounds to their presence at nuclear weapons sites and they might act as agents for the United States. CTR is important not just for the security of Russia and the United States but for the entire world. Problems or not, we need to find a way to make it work, and we must not relax because its continued success is not guaranteed.

Author's note: Ivan Oelrich is the Director of the Strategic Security Project at FAS.

FAS works toward the creation of the Digital Opportunity Investment Trust

By Michelle Roper

The productive working relationship among FAS's Learning Technologies project, the Learning Federation and the Digital Promise Project continues, and has enabled the projects to reach several significant milestones. Sharing a common vision for enhancing education, research and training through the use of information technologies, the projects have completed several major reports, disseminated a key report to each Member of Congress (accompanied by a "Dear Colleague" Letter from Senator Christopher Dodd [D-CT]), held a Congressional luncheon and testified before Congress during the last quarter.

Months of work in the making, Digital Promise's Report to Congress entitled: **Creating the Digital Opportunity Investment Trust: A proposal to transform learning and training in the 21st century** was formally presented at a Congressional luncheon on Thursday, October 23, held in the Mansfield room of the Capitol. The report had been authorized last spring in Public Law 108-7, which included an appropriation to the Federation of American Scientists for the Digital Opportunity Investment Trust, sponsored by Rep. Ralph Regula (R-OH). Senator Christopher Dodd accepted the Report on behalf of

the Congress. The luncheon was also attended by Senator Richard Durbin (D-IL) and Senator Daniel Akaka (D-HI), key congressional staff, executives from many of the non profit organizations that are part of the Digital Promise coalition and members of the press.

Two students, Kory Ann Haymore, of the Franklin W. Olin College of Engineering, and Haydee M. Cuevas, of the University of Central Florida, ceremonially presented the report to Congress. They were chosen as winners of a student essay contest conducted jointly by the Federation of American Scientists and the Learning Federation which asked students to describe their vision of how technology can revolutionize learning. Ms. Haymore's essay, "Math Animations: Math Lectures Taught by Animated Characters," detailed an innovative way to reverse the traditional use of classroom teaching and homework to teach math with animated lessons. Ms. Cuevas's essay, "Bringing a World of Dynamic Learning Experiences to Students via Virtual Field Trips," described how innovative use of virtual environments could augment teaching curriculum across a variety of domains, including K-12 education and workforce development. Their essays, along with three runner-up essays, can be

found on The Learning Federation's website: www.learningfederation.org.

During the luncheon, Senator Dodd recited the legacy of leadership in education that Congress has historically provided to ensure the progress of the society—the Northwest Ordinance, the Land Grant Colleges Act and the G.I. Bill. He stated that the Digital Opportunity Investment Trust (DO IT) is the heir to this legacy. Senator Durbin spoke about the important mandate that DO IT will fulfill by using the public resource of the electromagnetic spectrum for the broad public imperative of improving education and training. "Twenty years from now, people will look at this Report as the cornerstone of a 21st century effort to improve teaching and learning," Sen. Durbin said.

Federation of American Scientists' president, Henry Kelly, advised that, "Developing systems that work for teachers and students is probably the most important and difficult research problem the nation faces today." He noted that the learning science and technology roadmap outlined by the Learning Federation offered a real opportunity for innovation in this area.

Based on the Report's recommendations, Senators Christopher Dodd (D-CT), Olympia

International Summer Symposium on Science and World Affairs

By Stephanie S. Loranger

Since 1989 the Union of Concerned Scientists has organized an annual symposium on Science and World Affairs. The goals of the series are to cultivate arms control and international security analysts in countries lacking a strong tradition of public interest science and to establish an international community of researchers with similar interests and backgrounds. The 15th annual symposium was held this summer in Moscow, Russia; Ivan Oelrich and Stephanie Loranger from FAS were invited to participate.

Representatives from eleven nations attended, including scientists from Russia, China, Pakistan, Germany and Iran. Each participant gave a seminar on a current research project or interest. Topics of the seminars ranged from nuclear energy and non-proliferation, to missile defense, the weaponization of space, and biological weapons. Dr. Oelrich's talk on Gas Centrifuges, Uranium Enrichment, Nuclear Proliferation and Safeguards was very well received as was his introduction to nuclear non-proliferation. Dr. Loranger

participated in the morning session on biological weapons; her talk, (Security and the Biological Research Community), focused on the role the biological research community must play to prevent the exploitation of biotechnology for the creation of biological weapons.

Overall the meeting focused on nuclear non-proliferation. The morning session on biological weapons generated a great deal of discussion, making it clear that much more time could be devoted to the subject.

This experience provided the impetus for an FAS proposal to organize a parallel summer symposium on biosecurity. The series has been conceived as an annual international symposium of bioscientists and biosecurity professionals to address the new threats associated with advances in biological research and to work together in developing pragmatic solutions to manage these threats. The goals of the symposia would be to: develop and expand the international community working on biological weapons issues; provide resources to young scientists working on

biosecurity; and encourage more interaction and networking among scientists working in different countries on biological weapons and international security issues.

With first-hand knowledge, bioscientists are the most qualified to devise pragmatic strategies for modifying research methods to enhance security without stifling inquiry and discovery. The nuclear security paradigm is no substitute for the expertise of bioscientists since the distinction between peaceful and military research is not as clear-cut in biology as it is in nuclear physics. Open bioscientific knowledge, not engineered devices, is at the heart of the problem. It is our hope that this series of summer symposia will encourage young bioscientists to become engaged in formulating biosecurity policy in the international community.

Author's note: Dr. Stephanie Loranger is the Biology Issues Director at FAS.

Preventing Nuclear Proliferation in Latin America: The Treaty of Tlatelolco

By Sarah Chankin-Gould

Editor's Note: Sarah Chankin-Gould represented FAS as an Observer at the XVIII Regular Session of the General Conference of OPANAL (Agency for the Prohibition of Nuclear Weapons in Latin America and the Caribbean) in Havana.

In 1967, before the Nuclear Non-Proliferation Treaty (NPT) and at the height of the Cold War, the states of Latin America signed the Treaty of Tlatelolco, creating the world's first regional Nuclear Weapons Free Zone (NWFZ). Today, Latin America is off the radar screen of much of the arms control community, and nuclear proliferation in the hemisphere is not regarded as a significant threat. Yet rather than detracting from the importance of the Tlatelolco regime, this should serve as a reminder of what the Treaty has accomplished.

The Treaty of Tlatelolco has contributed to the development of non-proliferation norms in the region. It was signed only five years after the Cuban Missile Crisis, at which time Cuba remained committed to maintaining the option of nuclear weapons as long as its conflict with the US persisted. In addition, Argentina and Brazil were engrossed in their own race for nuclear arms during the 1970s and 80s. Today, following Cuba's 2002 ratification, all 33 states in the region have signed and ratified the Treaty.

The Treaty of Tlatelolco

The Treaty commits States Parties to use nuclear power for peaceful means. The parties are required to prohibit and prevent the testing, use, manufacture, production, acquisition, receipt, storage, installation, deployment and possession of nuclear weapons in their territory. To ensure its effectiveness, the Treaty includes two Additional Protocols committing states with responsibility for territories in the region (France, Holland, the UK and US), and the major nuclear powers (China, France, Russia, UK, and US) to maintaining the NWFZ.

The Agency for the Prohibition of Nuclear Weapons in Latin America and the Caribbean – OPANAL – serves as a secretariat for the Treaty regime. A five-member elected Council meets every two months, with states serving four-year terms. In addition, a General Conference of all Member States is convened every two years. The Agency is responsible for ensuring compliance with the Treaty and fulfilling the mandates of the Council and General Conference, including writing reports and maintaining contact with relevant states and international organizations. OPANAL and its Member States have shown a commitment to promoting nuclear

non-proliferation both in their own NWFZ and around the world.

The XVIII OPANAL General Conference

The XVIII General Conference of OPANAL was the first conference since the treaty entered into force for all states, and its location in Havana highlighted this fact. Significant topics addressed at the Conference, included: the transport of radioactive materials; a conference of all Nuclear Weapons Free Zones; the role of nuclear states; and the dilemma posed by possible US transport of nuclear weapons in the hemisphere. Each of these is discussed below.

Transport of Radioactive Materials

The threat of radioactive contamination of the marine environment and the related problem of transportation of radioactive materials has been a major issue on the agenda of OPANAL since 1987. The idea of creating a protocol to the Treaty of Tlatelolco addressing this issue has been presented at various General Conferences. However, it is the position of many States Parties that such a protocol would go beyond the reach and spirit of a treaty that focuses on the non-proliferation of nuclear weapons.

Despite the disagreement regarding the best venue for addressing the issue of transport, OPANAL has attempted to create opportunities for continued dialogue on the topic. States Parties have been encouraged to submit information and opinions on technical and legal methods of preventing radioactive contamination of the marine environment within the Treaty of Tlatelolco zone of application. In addition, OPANAL has opened avenues of communication with the IAEA and IMO (International Maritime Organization) on the subject. Discussion of this issue continued at the XVIII General Conference and the corresponding resolution encouraged continuation of similar measures. Clearly the problem of transport will remain a contentious and difficult matter.

Conference of NWFZs

OPANAL and its member states have spearheaded a proposal for an international conference of the parties of Nuclear Weapons Free Zones around the world. Such a conference would allow states and regions to share their experiences and help each other strengthen their NWFZs.

The process of developing broad-based international support for a conference is a lengthy and difficult one, and OPANAL and its Member States have made significant progress toward that goal. OPANAL has established contacts with the relevant authorities of other NWFZs and UN agencies. At the April 2002 Non-Aligned Movement meeting of Ministers of Foreign

Relations, the Chilean delegation promoted a conference that received majority approval. In addition, during this year's United Nations General Assembly, Mexico submitted a draft resolution proposing such a conference. The resolution was eventually withdrawn because of weak support, but even its introduction was significant. The submission of a resolution is often a first, important step toward building consensus.

At the 2003 General Conference, OPANAL member states reaffirmed their commitment to achieving an international conference of NWFZs and to fostering increased communication among them, in Resolution 466 "Strengthening of OPANAL."

Role of Nuclear States

Another key issue for OPANAL has been the role of the NPT-recognized nuclear weapons states in the Treaty regime. While not parties to the Treaty itself, the NPT ratification of Additional Protocol II commits them not to contribute to a violation of the Treaty, and not to use or threaten to use nuclear weapons against parties to the Treaty. All five states submitted "unilateral declarations" qualifying their ratification of the Protocol. Since the end of the Cold War, OPANAL has called into question the necessity of such declarations, pointing out that the purported reason for the declarations – self defense – is already guaranteed in the UN Charter. They are concerned that by retaining the option of nuclear force, the declarations undermine the Treaty.

The Chinese declaration is the least controversial because it states clearly that China will not be the first to use nuclear weapons and will not threaten or use nuclear weapons against the Latin American NWFZ. The French declaration asserts that its ratification of the protocol is understood not to be an obstacle to the right of self defense. This statement leaves room for the use of nuclear weapons in self defense, even against non-nuclear powers. Finally, the declarations of Russia, the UK, and US are related to the self-defense but have even broader applications. All three countries reserve the right to use nuclear weapons against non-nuclear Latin American states in the event that those states commit acts of aggression with the support of a nuclear-weapons state.

In 2003, the Secretariat of OPANAL sent notes to the foreign ministers of all five countries requesting that they review and consider withdrawing or modifying their declarations. During the XVIII General Conference, China, France, the UK and Russia indicated that they are studying the request, and reiterated their continued support of the Latin American NWFZ. The US made no statement.

US transport of nuclear weapons

During the Conference, several representatives – particularly those from Venezuela and from the Puerto Rican NGOs present – expressed concern about possible US violations of the spirit or letter of the Treaty. These parties are

concerned that the US may have ships with nuclear weapons that travel through the territorial waters of Puerto Rico and make stops at the bases there, and at US military bases throughout the hemisphere. Although some OPANAL members claim that this is a violation of US obligations under the Treaty, the situation is unclear. In fact, US understandings at the time of ratification stated that the Protocols did not affect the right to grant or deny transport or transit privileges regardless of cargo, and did not affect the freedom of the seas or passage through territorial waters. Nonetheless, OPANAL members

remain concerned that such actions by the US would undermine the integrity of the Treaty.

Conclusions

The creation of a Nuclear Weapons Free Zone including 33 countries is no small feat, and speaks for the normative power of the Treaty. Over the past 36 years OPANAL has seen the transformation of a region from one with several grave emerging nuclear threats to a truly Nuclear Weapons Free Zone. The XVIII OPANAL General Conference recognized that complete ratification did not mean that

OPANAL's work is finished either regionally or globally. Within the hemisphere, OPANAL is grappling with issues of transport of radioactive materials, the role of nuclear weapons states, and possible US violations of the Treaty. Externally, they want to create an international conference. This is an ambitious project; yet, in 1967 the creation of a NWFZ in Latin America was itself highly ambitious, and much has been accomplished since then.

Author's note: Sarah Chankin-Gould is a Scoville Peace Fellow with the Arms Sales Monitoring Project at FAS.

FAS Congratulates Richard L. Garwin

FAS congratulates Richard L. Garwin for receiving the National Medal of Science, the nation's highest honor for science and engineering. Dr. Garwin's contributions to magnetic resonance techniques while working for IBM and his numerous contributions to improving national security were cited in the award. He was presented the medal on November 6th by President Bush.

FAS has benefited greatly from collaboration with Dr. Garwin, who is a current member of FAS' board of directors. A collection of Dr. Garwin's writings is housed on FAS' website at: <http://www.fas.org/rlg/index.html>. His older writings demonstrate not only his tremendous grasp of technical subjects, but also his prescience concerning future developments in warfare.

For example, in a 1972 paper on the future of the US military, he argues persuasively as to the impact of a

global navigation system for guiding munitions as a means to reduce collateral damage and save money.

Currently, as the Philip D. Reed Senior Fellow for Science and Technology at the Council on Foreign Relations, Dr. Garwin has worked tirelessly to reduce the numbers of strategic nuclear weapons, create effective strategies for countering terrorism, and provide technically grounded advice on the implications of space weaponization, among other subjects. His ability to transform his ideas into concrete results has made it clear how scientists can affect policies at home and abroad and help to make the world a safer place for us all.

Snowe (R-ME) and Richard Durbin (D-IL) have recently introduced legislation, The Digital Opportunity Investment Trust Act (S. 1854). They will be seeking additional Senate sponsors from both sides of the aisle.

The Trust also received attention on the House side as the Energy and Commerce Subcommittee on Telecommunications and the Internet held a hearing entitled "Digital Dividends and Other Proposals to Leverage Investment in Technology" on Wednesday November 19th. Rep. Edward Markey (D-MA) introduced legislation for a range of projects to ensure that the public would benefit from the funds that will be generated from the auction of the spectrum. This was the second hearing the Trust has received on this bill. On this occasion Mr. Newton Minow, co-chair of Digital Promise and former head of the FCC, Mr. James Welbourne, Director of the New Haven Free Public Library System, and Dr. Eamon Kelly, former director of the National Science Board and a newly elected FAS Board member, testified on behalf of DO IT. The hearing was well attended by members from both sides of the aisle and the DO IT proposal that could improve education and training "from k to gray", and access to the nation's cultural treasures, attracted considerable interest.

The report, the Congressional testimonies, a summary of the hearing and the legislation can be accessed online at

www.digitalpromise.org.

Hardcopies of the report can be obtained by contacting Michelle Roper at 202. 546. 3300 or by sending an email request to digitalpromise@fas.org.

Coinciding with the presentation of the Digital Promise report, the Learning Federation has released five technical roadmaps, an executive summary of its research findings, and a management model for implementing the R & D roadmap. The roadmaps were produced with the help of nearly a hundred leading researchers in learning science and information technology and describe a pre-competitive, platform-neutral research plan to stimulate development and dissemination of next generation learning tools.

Each component roadmap addresses a critical learning science and technology R&D focus area, specifically: instructional design, question generation and answering systems, learner modeling and assessment, simulations and exploration environments and tools for building and maintaining advanced learning systems. Each roadmap provides an assessment of the R&D needs, identifies key research questions and technical requirements, details the chronology of the R&D activities over the next 3 - 10 years and specifies long-term goals and shorter-term benchmarks for the efforts. Collectively the roadmaps describe a research plan to develop and disseminate a range of interoperable, reliable software

tools that can lower the cost of entry for educational materials and systems. The complete series of roadmaps is available at www.learningfederation.org.

Author's note: Michelle Roper is the manager of the Digital Promise Project and coordinator of special projects at FAS.

Staff News

FAS Welcomes New Members of Staff

Sarah Chankin-Gould is a Scoville Peace Fellow and chose to spend her fellowship with the Arms Sales Monitoring Project at FAS. She graduated from Occidental College in May 2003 with a B.A. in Diplomacy and World Affairs and in Spanish.

Christine Palumbo began working with FAS as an intern for the Learning Technologies Project and has joined FAS full-time serving as both the Project Assistant for the Digital Promise Project and the Administrative Assistant for the Organizational Manager. Christine received her B.A. from Hamilton College in Clinton, NY with a major in government and a minor in philosophy in the spring of 2002.

Rachel Jagoda joined the FAS staff in October as Project Manager for Housing Technology. The housing technology project focuses on designing energy-efficient and structurally sound housing for communities in the United States and abroad. Current plans include creating earthquake and fire resistant housing in California and Afghanistan.

Rachel received her bachelor's degree in physics from Georgetown University in 2002. Prior to coming

to FAS, she worked in the Public Affairs Department at the American Society for Engineering Education, where she worked to educate the public on the benefits of science education in the United States and to encourage Congress to increase funding for education and research. She also worked in Government Affairs for the American National Standards Institute, which coordinates with the US government to administer the US standards system.

Becky Sullivan joined the FAS team in October 2003 as a research assistant for the Learning Technologies Project. Becky received her Bachelor of Science degree in business administration with a minor in biology from the University of Richmond in May 2003. At FAS she will provide research assistance, develop and maintain the Learning Federation's web presence, and coordinate conferences and workshops.

Benn Tannenbaum recently joined FAS as the Senior Research Associate for the Strategic Security Project. Dr. Tannenbaum's research at FAS focuses on nuclear weapons. He also coordinates FAS's Congressional outreach efforts.

Prior to his current appointment, Dr. Tannenbaum served as the 2002-2003 American Physical Society Congressional Science Fellow.

During his fellowship, Dr. Tannenbaum worked for Representative Edward J. Markey (D-MA) on nonproliferation issues. This work included several key nuclear policy amendments, numerous oversight letters and staffing the House Bipartisan Task Force on Nonproliferation. The legislative work focused on nuclear "bunker busters", missile defense, Iran's nuclear program and preventing US nuclear technology from being transferred to North Korea. The oversight letters covered issues ranging from the disbanding of the NNSA Advisory Committee, to the failure to secure known nuclear sites in Iraq, to presenting a detailed plan to solve the nuclear crisis on the Korean Peninsula. Through the Bipartisan Task Force on Nonproliferation, Dr. Tannenbaum brought nationally recognized experts on topics such as Iran's nuclear program and political situation, dirty bombs, and the Biological Weapons Convention to brief Members of Congress and their staffs. His final Task Force event had Dr. Jane Goodall and Michael Douglas addressing the need for strong, multilateral institutions to solve problems such as nuclear proliferation and environmental damage.

Before his fellowship, Dr. Tannenbaum worked as a Postdoctoral Fellow at the University of California, Los Angeles. At UCLA he was involved in the Compact Muon Solenoid experiment at CERN, in Geneva,

Switzerland, and the Collider Detector Facility at the Fermi National Accelerator Laboratory outside Chicago, Illinois. He received his Ph.D. from the University of New Mexico in 1997. His dissertation involved a search for evidence of supersymmetry. None was found.

Notices:

The Strategic Security Project at FAS has created a new section of the FAS website (www.fas.org/ssp/1-pagers/) to share information about a variety of science-related security issues. These short articles include summaries of many FAS reports, such as upcoming dirty bombs and gas centrifuge uranium enrichment technology, as well as more basic information, such as why monitoring krypton-85 is an indicator of plutonium reprocessing. We welcome your suggestions for additional topics. If appropriate, we will work with you to develop the best possible content. Please contact Dr. Benn Tannenbaum (btannenbaum@fas.org; 202 546 3300) to submit ideas.

FAS has created a new email list for members, fas-announce. This list will be used to inform FAS members about FAS activities, such as upcoming FAS-related events, important updates to the organization's website, and opportunities for our members to contact elected officials. The list is for announcement purposes only; it is not a discussion list. To join, please visit <http://lists.fas.org/mailman/listinfo/fas-announce>.

FAS Board News

On December 8, 2003, FAS held its semi-annual Board of Director's meeting. The meeting was led by new Chair Tara O'Toole, who was elected by the membership in August 2003. Also joining the group was newly elected Vice-Chair Steven Weinberg; three newly elected members: Eamon Kelly, Arthur Rosenfeld, and Richard Wald; and the three newly appointed members: François Castaing, David Foster, and Kumar Patel.

The combination of new and incumbent board members gives FAS a spectacular and diverse Board. The FAS staff has great expectations about what we can do together in the next few years. We are proud to introduce the new members of the FAS Board of Directors:

François J. Castaing is former Vice President and Executive Vice President of Vehicle Engineering at Chrysler Corporation. Mr. Castaing currently serves on the Boards of Exide Technologies, Amerigon, Durakon Industries, NextEnergy, and FIRST. He is the chairman of the New Detroit Science Center and the University Cultural Center Association in Detroit, Michigan, and Chairman Emeritus of the French-American Chamber of Commerce, Michigan Chapter. Additionally, Mr. Castaing is a Society of Automotive Engineers (SAE) Fellow and a member of the U.S. National Academy of Engineering.

David L. Foster is President of IOMA, a professional education and training publisher, which he founded in 1982 in New York City. He is also on the Boards of three other publishing companies: BNA, Pike & Fischer, Inc., and Kennedy Information. Mr. Foster is the Vice Chair of the Board of Bates College in Lewiston, ME, serving on its investment, budget, large gifts, and honorary degree committees. He's also on the finance committee of Symphony Space, the arts organization that produces NPR's Selected Shorts, among other programming.

Eamon Michael Kelly is President Emeritus and Professor in the Payson Center for International Development & Technology Transfer at Tulane University. Dr. Kelly is the former Chairman of both the Association of American Universities and the Satellite Working Group. His current teaching and research interests focus on the role of science and technology, especially information technology, in the developing world.

Tara O'Toole has been elected our new chair. Dr. O'Toole is a Board-certified internist and occupational medicine physician with clinical experience in academic settings and community health centers. Dr. O'Toole is currently heading up the new Center for Biosecurity at the University of Pittsburgh Medical Center (UPMC). Previously, she served as Director of the Johns

Hopkins University Center for Civilian Biodefense Strategies and Public Health Professor at the Johns Hopkins School of Public Health. She is co-editor in chief of the new journal Biosecurity and Bioterrorism – Biodefense Strategy, Practice and Science.

Kumar Patel is a founder of Pranalytica, a medical instrumentation and communications equipment company. He has taught as a Professor of Physics and Astronomy, Professor of Chemistry and Professor of Electrical Engineering at UCLA, where he was also Vice Chancellor of Research. He is a fellow of the Institute of Electrical and Electronic Engineers, the American Physical Society, the Optical Society of America, the American Academy of Arts and Sciences, the Laser Institute of America, and the Association for Advancement of Arts and Sciences.

Arthur H. Rosenfeld is Commissioner to the California Energy Commission, where he the presiding member of the Research, Development and Demonstration Committee and the Dynamic Pricing Committee and second member of the Energy Efficiency Committee. From 1994-1999, Dr. Rosenfeld served as Senior Advisor for the US Department of Energy's Assistant Secretary for Energy Efficiency and Renewable Energy.

Richard C. Wald is the Fred Friendly Professor of Media and Society at Columbia University and

a consultant to ABC News. In addition, Mr. Wald is a member of the advisory board of the Knight Fellowship at Stanford University, a member of the Board of Visitors of the School of Communication at the University of Colorado, Boulder, and a member of the Board of the Correspondents Fund and the Center for Communication. He is also the Chairman of the Board of the Columbia Daily Spectator, the Columbia College daily newspaper.

Stephen Weinberg has been elected our new Vice-Chair. He is the Jack S. Josey-Welch Foundation Chair in Science and Regental Professor and the Director of the Theory Research Group at the University of Texas at Austin. Dr. Weinberg and two of his colleagues earned the Nobel Prize in Physics in 1979. He is the author of six books and over 200 scientific articles on elementary particle physics, cosmology and other subjects, one of which is the most frequently cited paper on particle physics of the past fifty years. He also writes for The New York Review of Books and other periodicals.

The incumbent members are:

Rosina Bierbaum is Dean of the School of Natural Resources and Environment at the University of Michigan, as well as a Professor of Natural Resources and Environmental Policy. Dr. Bierbaum is a fellow of the American Association for the Advancement of Science (AAAS) and serves on the

National Academy of Science's Board on Atmospheric Chemistry and Climate. Dr. Bierbaum has published widely in professional journals and continues to lecture frequently on natural resources management and global change.

Richard L. Garwin is Philip D. Reed Senior Fellow for Science and Technology at the Council on Foreign Relations, New York and IBM Fellow Emeritus at the Thomas J. Watson Research Center, Yorktown Heights, New York. Dr. Garwin is a Fellow of the American Physical Society and of the American Academy of Arts and Sciences and a member of the National Academy of Sciences. He is a long-time member of Pugwash and has served on the Pugwash Council. Dr. Garwin is co-author of many books, including his most recent, *Managing the Plutonium Surplus: Applications and Technical Options* (1994). He is a 2003 recipient of the National Medal of Science.

Lawrence Grossman is former president of NBC News and PBS, an advertising agency owner, holder of the Frank Stanton First Amendment Chair at the Kennedy School of Government, and senior fellow and visiting scholar at Columbia University. He currently serves as co-chairman of the Digital Promise Project, and as trustee of Connecticut Public Broadcasting and various nonprofit health organizations. Mr. Grossman also serves as a television columnist for

Columbia Journalism Review and as a Dupont-Columbia Journalism Award juror. He is the author of *The Electronic Republic: Reshaping Democracy in the Information Age* (1996).

Jane Dale Owen serves as the President of the Houston-based nonprofit organization Citizens League for Environmental Action Now (CLEAN). Ms. Owen has been actively involved as a Board member of the Blaffer Gallery, has served on the Executive Committee of the Moores School of Music, University of Houston and serves on the Houston Museum of Fine Arts Film Committee. Ms. Owen is also an avid supporter of the Houston SPCA and Planned Parenthood. She has worked with numerous agencies including the EPA, Harris County Pollution Control, local citizen groups, Sierra Club, Citizen Environmental Coalition, and business and industrial leaders.

Judith Reppy is Professor of Science & Technology Studies and Associate Director of the Peace Studies Program at Cornell. Dr. Reppy has studied the economics of defense, security and peace for many years. She also researches and teaches Ethical, Legal & Social Issues with the Cornell Genomics Initiative, where her current research focus is on the role of standards in technology transfer between industrialized and developing countries.

Shankar Sastry is the NEC Distinguished Professor of Electrical Engineering and Computer Sciences and Bioengineering and Chair of the Electrical Engineering and Computer Sciences EECS at the University of California at Berkeley. He is a Fellow of the Institute of Electrical and Electronics Engineers (IEEE). He is an Associate Editor of the IMA Journal of Mathematical Control and Information, the International Journal of Adaptive and Optimal Control, and the new Journal of Sensors and Biomimetic Systems. Dr. Sastry's recent work focuses on the development of a "Digital Human," an open architecture digital simulation of the human body currently underway at the National Science Foundation in cooperation with several other leading research institutions, including FAS.

Maxine Savitz advises on R&D management, energy and environmental policy, materials development, and technology transfer with the Washington Advisory Group. Her areas of expertise also include energy efficiency in the transportation, industry, and buildings sectors, aerospace technology, and integration of R&D between laboratories and business units. Dr. Savitz is a member of the National Academy of Engineering, the AAAS, the National Science Board, and advisory bodies for Oak Ridge National Laboratory and Pacific Northwest National Laboratory. Dr. Savitz also serves on the Board of Directors of the Electric Power Research Institute (EPRI) and the

American Council for an Energy Efficient Economy.

Jonathan Silver is the founder and a Managing Director of Core Capital Partners, a private equity fund which invests in early-stage technology companies and provides expansion capital for technology-driven small and mid-sized operating companies. Mr. Silver has held senior positions in both the public and private sector. He currently serves on the Boards of the EarthSat Corporation, CorrFlex Graphics, and Core Communications, as well as the Board of American Forests, People for the American Way, the Baltimore-Washington Venture Group, and the Arena Stage Theatre.

Gregory Simon, J.D. is President of the Center for Accelerating Medical Solutions, as well as Chair of Infotech Strategies, an information and communications technology consulting firm. Prior to joining the private sector, Mr. Simon served as Staff Director of the Investigations Subcommittee of the House of Representatives' Science, Space and Technology Committee; he then went on to become Chief Domestic Policy Advisor to Vice President Al Gore. While working on the Hill and at the White House, Mr. Simon worked on a number of health, space, and biotechnology policy initiatives.

The country faces a formidable set of challenges in national security, education, environment, and other areas where the scientific and engineering community can make

critical contributions. FAS has an exciting portfolio of projects that can help ensure these contributions are made effectively and delivered where and when they're most needed. The FAS staff is confident that our new Board will help us address these issues and reach our goals. We welcome our new and incumbent members and look forward to their future support and leadership.

Leaving a Legacy of Peace

by Sharon Gleason

The Federation of American Scientists hopes to continue efforts to advance sound science in public policy for generations to come. We'd like your help in accomplishing this goal.

As we move into 2004, please think about FAS in your estate and financial planning. Please remember that your will, life insurance policies, retirement accounts and other planned giving vehicles may offer exceptional opportunities for leaving the lasting legacy of peace.

It is easy to provide a bequest to the Federation of American Scientists:

- You may leave the Federation of American Scientists a specific amount of cash or specific property. Sample wording, "I give the sum of \$250,000 to the Federation of American Scientists," or I give 10,000 shares of ABC Corporation to the Federation of American Scientists.
- You may leave the Federation of American Scientists a fixed percentage of your estate. Sample wording, "I give 30 percent of the residue of my estate to the Federation of American Scientists."
- You may leave the Federation of American Scientists all or part of the residue of the estate after bequests to other beneficiaries have been made. Sample wording, "I give the residue of my real and personal estate to the Federation of American Scientists."

Whichever methods you choose, if properly structured, your bequest will be fully deductible from your estate, thus decreasing any tax liabilities. The estate tax charitable deduction is unlimited.

We at the Federation of American Scientists would be pleased to help you and your financial advisor choose a way to support the Federation of American Scientists's important work that best fits your personal philanthropic goals. For more information about the advantages of considering the Federation of American Scientists in your estate planning, please contact Sharon Gleason at sgleason@fas.org or 202.454.4680.

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Attention FAS Members!

In our continuing effort to provide FAS members with lively and timely articles in national security policy and other areas of science and technology policy, we are inviting members to submit proposals for articles in areas of interest to FAS members (maximum 1000 words). Selection of the articles is at the discretion of the Editor. Completed articles will be peer reviewed.

Proposals should be sent to the Editor, PIR, Federation of American Scientists, 1717 K St. NW, Suite 209, Washington, DC 20036, or to fas@fas.org. Please provide us with your full address including email in all correspondence.

The FAS Public Interest Report

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