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PHYSICS & SOCIETY

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Editor's Comments

As reported in our July edition, Assistant Editor Jonathan Wurtele and myself will be stepping down from our positions with P&S following publication of the April, 2013, edition. As this edition was being prepared for publication, we learned that the search committee under the able direction of Barbara Levi has located a pair of most qualified successors: Andrew Zwicker of the Princeton Plasma Physics Laboratory (PPPL) as Editor, and Laura Hopkins of Lawrence Livermore National Laboratory (LLNL) as Assistant Editor. Andy is the Head of the Science Education Program at PPPL. He received a bachelor's degree in physics from Bard College and a Ph.D. in physics from Johns Hopkins University, where he developed spectroscopic diagnostics for fusion energy experiments. In 2008, he served as the Chair of the Forum on Physics and Society, and was Secretary/Treasurer of FPS from 2001-2006. Currently, he is a member of the APS Committee on Education, though his term ends in 2012. In 2006, the American Association of Physics Teachers included him in their list of 75 leading contributors to physics education. He and a collaborator won the 2006 Art of Science competition at Princeton University for a photograph entitled "Plasma Table," and he is now the Chair of the organizing committee for the competition. He is also a member of the Education and Workforce Development task group for the Department of Energy's "Energy Efficient Buildings Hub," and teaches a freshman writing seminar at Princeton University, "The Ethics of Human Experimentation." His current research interests are in dusty plasmas, plasma speakers, and plasma education. Laura Hopkins is currently a physicist at LLNL, where her research focuses on inertial confinement fusion. She received her Ph.D. in Plasma Physics from Princeton University in 2010, and in 2010-2011 held an American Physical Society Congressional Science Fellowship. As a Congressional Science Fellow, she served as a scientific advisor for U.S. Senator Kent Conrad and on the Subcommittee on Terrorism, Nonproliferation, and Trade of the U.S. House of Representatives Committee on Foreign Affairs. During her graduate studies, Laura was a National Nuclear Security Administration (NNSA) Stewardship Science Graduate Fellow at the Princeton Plasma Physics Laboratory. I am pleased to welcome Andy and Laura to the Newsletter, and to know that it will be passed on to good hands.

In this edition –

Under News of The Forum, we congratulate Jeremy Bernstein and Geoffrey West, respectively the winners of the Forum's 2013 Burton and Szilard Awards. We also recognize three new APS Fellows nominated through the Forum: Robert Bari, Mitra Dutta, and Arian Pregenzer. Awardees and new Fellows will formally be recognized at the FPS Awards Session to be held at the April APS meeting; descriptions of Forum-sponsored sessions scheduled for the March and April meetings appear below. Thanks are due the awards and Fellowship committees for their careful work.

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IN THIS ISSUE

With this edition of P&S, we welcome Richard Wiener of Research Corporation as the newest member of P&S's editorial board. Richard is replacing Barbara Levi, who rotated off the board in late 2012.

As a follow-up to the article on the President's Blue-Ribbon Commission on nuclear waste in our July 2012 newsletter, we reprint part of a recent AIP FYI bulletin on a bill aimed at addressing some of the Commission's findings.

At the Society of Physics Students (SPS) 2012 Quadrennial Physics Congress, which took place in Orlando, Florida, over November 8-10, 2012, FPS sponsored three awards for student poster papers: one first-place and two second-place awards for posters which included the societal impact of physics as part of their studies. The first place winner was Allen Scheie (Grove City College), and the second-place winners were Kofi Christie (Morehouse College) and Matthew Goszewski (Grove City College). We congratulate the winners, and reprint the abstracts from their posters.

We have a plethora of contributed material for this edition. A letter from longtime contributor Dave Hafemeister informs us that his equation-oriented book, Physics of Societal Issues: Calculations on National Security, Environment and Energy, is available at a very attractive price. Two of our feature articles for this edition cover some interesting ground in the area of nuclear physics. Alex DeVolpi writes on how available coolant-monitoring technology could have helped the operators of the Fukushima Dai-ichi nuclear power plant better manage the disaster that unfolded with their reactors following the tsunami of March, 2011, and could still be useful as they work to deal with the remains of those devices. Based on a talk given by Mike Larson at the 2012 APS April meeting in Atlanta, an article prepared by myself describes the history and activities of the Nuclear Emergency Support (formerly Search) Team – NEST. Readers can be assured that NEST stands very ready to respond to any potential nuclear threat. Our third feature article, by Rees Kassen of the University of Ottawa, offers some observations on efforts to bring science and engineering advice to the Parliament of Canada in a non-partisan way. Dr. Kassen's article serves as a reminder that there are many ways to be involved in such activities. On this side of the border, Forum members should consider the AAAS and APS Executive and Congressional Fellowships.

Our book review for this edition, by Michael DuVernois, examines the German experience with supporting solar energy development.

Enjoy!

Message from the FPS Chair

Pushpa Bhat, Fermilab (pushpa@fnal.gov)

A letter from President Barack Obama congratulating the Forum and praising its work in bringing science and society issues to the attention of the physics community was one of the highlights of the 40th anniversary celebration event of the FPS at the April 2012 meeting in Atlanta, GA. Another noteworthy feature of the meeting was a special FPS panel session on "American Science & America's Future" that garnered considerable attention in the news and social media. (See, for example, July 2012 P&S Newsletter for details on the panel, and http://www.huffingtonpost.com/2012/04/06/science-america-crisis-physics-society_n_1408244.html) Our "academic" year got off to a great start and the executive committee is committed to making the fifth decade of the FPS even better!

The activities of the Forum since the successful annual meetings have proceeded very well. Our committees on FPS-sponsored APS prizes/awards and fellowships have recognized exceptional individuals who have made outstanding contributions to physics and to the advancement of societal issues connected to physics. FPS has also awarded three prizes at the 2012 Sigma Pi Sigma Quadrennial Congress for outstanding undergraduate student posters that involved issues at the interface of physics and society.

The FPS program committee has been busy planning plenary sessions for the 2013 APS annual meetings. FPS is collaborating with other APS forums and topical groups to create joint sessions where there are overlapping interests. More information on the planned sessions can be found in the Forum News section in this newsletter. Encouraged by the overwhelming positive response to the panel session on "American Science & America's Future" at the 2012 April meeting, the program committee endorsed my plan to promote a national dialogue on the topics in panel sessions at the upcoming March (March 18-22, Baltimore, MD) and April (April 13-16, Denver, CO) APS meetings in 2013. We expect to have a mix of prominent practicing scientists, policy makers and advisors as panelists for these sessions. We hope that many of you will participate in these very important discussions. A web page will be set up for APS members to submit questions and comments for these panels. We are also exploring the possibility of a live web cast of the panel sessions. Again, I hope that the discussions will provide us with ideas for action; action that we, as citizens, scientists and leaders, should undertake to help strengthen the US science & technology enterprise and leadership in the 21st century global society.

We are all acutely aware, that, in spite of the enormous progress in science and technology and the unprecedented prosperity and affluence they have brought to sections of our society, the world faces enormous challenges. I believe that scientists, through active engagement and action, can help create a better world. Therefore, I propose that FPS members devote a fraction of their time in grassroots efforts to engage the broader community of scientists and the general public (in local communities) in discussions of scientific issues that impact society. I very much look forward to hearing from and working with many of you on these efforts.

Please feel free to email me with suggestions at pushpa@fnal.gov. I hope to see you at the FPS plenary sessions and the business meeting at the upcoming 2013 APS annual meetings.

FORUM NEWS

2013 Forum Award Recipients Announced

Recipients of the Forum's Joseph A. Burton and Leo Szilard Lectureship Awards for 2013 have been announced. The Burton Award is given to recognize outstanding contributions to the public understanding or resolution of issues involving the interface of physics and society. The recipient for 2013 is Jeremy Bernstein (Emeritus, Stevens Institute of Technology) "For his important contributions to public understanding of the physics of nuclear policy and for his graceful and subtle explanations of modern science in his books and articles over many decades." The Leo Szilard Lectureship Award is given to recognize outstanding accomplishments by physicists in promoting the use of physics for the benefit of society in such areas as the environment, arms control, and science policy. The 2013 recipient of this award is Geoffrey West of the Santa Fe Institute "For path-breaking work on the origin of universal biological scaling laws and quantitative models for structural and functional design of organisms, and for theoretical insights about the long-term sustainability of cities." P&S extends congratulations to Drs. Bernstein and West on their well-deserved recognitions, and thanks the members of the selection committee for their work: Peter Zimmerman, Arian Pregenzer, and Siegfried Hecker. The deadline for nominations for the 2014 Burton and Szilard Awards is July 1, 2013. Information on Forum prizes and awards can be found at www.aps.org/units/fps/awards/index.cfm.

New Fellows Elected through the Forum

Forum members Robert Bari, Mitra Dutta, and Arian Pregenzer were elected to APS Fellowship at the November, 2012, APS Council meeting through FPS nomination. Bari (Brookhaven National Laboratory) was recognized for his many contributions to nuclear power reactor safety, security, and proliferation resistance, including major contributions to probabilistic risk assessment and to methods for analyzing proliferation resistance of complex nuclear systems. Dutta (University of Illinois, Chicago) is being recognized for her research leadership and administration in government and academia, through which she has supported applications of physics for society, outreach to the public, and enhancement of physics education. Pregenzer (Sandia National Laboratories; recipient of the 2012 Forum Burton Award) was recognized for her leadership in advancing arms control monitoring and verification technologies and for establishing and leading international scientific cooperation for arms control and international security. These new Fellows and the recipients of the Burton and Szilard awards will be recognized at the Forum Awards session at the April meeting (see below). It is not too early to think about nominees for next year; the deadline is June 1, 2013.

Richard Wiener joins P&S Editorial Board

We welcome Richard Wiener, a program officer at Research Corporation, as the newest member of P&S's editorial board. Richard, who is just wrapping up a three-year term as a member of the FPS Executive Committee, replaces Barbara Levi, who rotated off the board in late 2012. Richard earned a BA in philosophy at UC-Berkeley, and a PhD in physics at the University of Oregon.

FPS to Host Sessions at APS March Meeting

The annual March meeting of the APS will be held at the Baltimore Convention Center from March 18–22, 2013. FPS is hosting three sessions; tentative lists of speakers and some presentation titles are given here. Not all details of Forum-sponsored sessions were available at press time, and are subject to change.

Tuesday March 19, 2013, 8:00 AM

THE IMPACT OF HYDRAULIC FRACTURING

Session Organizer & Chair: Richard Wiener (Research Corporation for Science Advancement)

Co-Sponsored by FPS and the APS Group on Energy Research and Applications (GERA).

Hydraulic fracturing uses pressurized fluid to propagate fractures. Its use for hydrocarbon recovery has economic benefits, but also potential environmental impacts. The session will focus on the underlying physics to better understand this issue.

Speakers:

Susan Burden (U.S. Environmental Protection Agency)

Murray Hitzman (Colorado School of Mines)

Francis O'Sullivan (MIT)

Robert Jackson (Duke University; invited).

Wednesday March 20, 2013, 11:15 AM

AMERICAN SCIENCE AND AMERICA'S FUTURE

Session Organizer & Chair: Pushpa Bhat (Fermilab)

How can the US maintain its competitive edge in science and innovation? We will address issues in scientific research, science education, science & technology policies, S&T workforce development, and impacts on industry and economy.

Rep. Rush Holt (U.S. House of Representatives)

Shirley Jackson (President, Rensselaer Polytechnic Inst; invited)

Subrah Suresh (Director, National Science Foundation; invited)

Sheldon Glashow (Boston University)

Thursday March 21, 11:15 AM

SCIENCE IN THE NEW ADMINISTRATION

Session Chair: Micah Lowenthal (National Academy of Sciences)

The new administration, coming in to office in January 2013, will mark a fresh start in science policy. We will explore the plans and directions for science policy over the coming four years.

William Brinkman (DOE) Science and the National Agenda

Robert Jaffe (MIT) Science Informing Policy in the New Administration

William Colglazier (U.S. Department of State)

Patricia Falcone (US Offc of Sci & Technology Policy; invited)

David Goldston (Natural Resources Defense Council)

FPS to Host Sessions at APS April Meeting

The APS April meeting will be held at the Sheraton Denver Downtown Hotel, April 13-16, 2013. FPS is sponsoring six sessions; tentative lists of speakers and some presentation titles are given here. Not all details of Forum-sponsored sessions were available at press time, and are subject to change.

Saturday April 13, 10:45 AM

FPS AWARDS SESSION

Session Organizer & Chair: Pushpa Bhat (Fermilab)

Jeremy Bernstein (Stevens Institute of Technology); Burton Forum Award

Geoffrey West (Santa Fe Institute); Szilard Lectureship Award

Saturday April 13, 3:30 PM

PHYSICISTS AS SCIENCE ADVISORS

Session Organizer & Chair: Micah Lowenthal (National Academy of Sciences)

Physicists play important roles in providing science advice. Physicists who have served in advisory capacities will discuss topics, challenges, and careers in advising the US government on science aspects of policy questions.

Tony Fainberg (Institute for Defense Analysis) Physicists as Science Advisors

Steve Fetter (University of Maryland)

Valerie Thomas (Georgia Institute of Technology) Science Advice at the EPA

John Morgan: Science Advice at the Department of Defense

Sunday April 14, 10:45 AM

LOW CARBON ELECTRICITY

Session Organizer & Chair: Valerie Thomas (Georgia Institute of Technology)

Co-Sponsored by FPS and the APS Group on Energy Research and Applications (GERA)

This session will address technologies and system approaches for low carbon electricity generation in the U.S.

Arun Majumdar (University of California, Berkeley) Sustainable Energy

Trieu Mai (National Renewable Energy Laboratory) Renewable Electricity Futures

Christiana Honberg (Arizona State University) Advances in Solar Energy

Sunday April 14, 1:30 PM

LOW CARBON TRANSPORTATION

Co-Sponsored by FPS and the APS Group on Energy Research and Applications (GERA)

The focus of this Invited Session is to present the main scientific and policy challenges to achieving low-carbon transportation.

Session Chair & Organizer: Ellen Stechel (Sandia National Laboratories)

Michael Tamor (Ford Motor Company) Electricity as a Transportation Fuel

Jane Davidson (University of Minnesota) Solar Thermo Chemical Approaches for the Production of Transportation Fuels

Todd West (Sandia National Laboratories) Biofuels and Technology/Policy Trade-offs for Light Duty Vehicles

Monday April 15, 3:30 PM

AMERICAN SCIENCE AND AMERICA'S FUTURE

Session Organizer & Chair: Pushpa Bhat (Fermilab)

How can the US maintain its competitive edge in science and innovation? We will address issues in scientific research, science education, science & technology policies, S&T workforce development, and impacts on industry and economy.

Lisa Randall (Harvard University)

Saul Perlmutter (University of California, Berkeley)

Tuesday April 16, 1:30 PM

TECHNICAL ASPECTS OF THE COMPREHENSIVE TEST BAN TREATY

Session Organizer & Chair: Micah Lowenthal (National Academy of Sciences)

Scientists will describe recent developments in science and technology for monitoring nuclear explosions using radionuclide detection, seismology, and satellite technology.

Ted Bowyer (Pacific Northwest National Laboratory) Status and Challenges of Radionuclide Detection for Detecting Nuclear Explosions

Raymond Willeman (IRIS - Incorporated Research Institutions for Seismology) Seismic Detection of Nuclear Explosions.

Randy Bell (National Nuclear Security Administration) Research for Detecting Nuclear Explosions Using Other Phenomena

AIP FYI on Senate Bill on Nuclear Waste

[In the July, 2012, edition of P&S we ran an article by Susanne and Robert Vandenbosch on the President's Blue Ribbon Commission on nuclear waste. We reprint here part of a recent AIP FYI on a senate bill recently introduced to address the Commission's findings; the full FYI can be found at http://www.aip.org/fyi/2012/133.html - Ed.]

The Senate Energy and Natural Resources Committee held a hearing to review legislation that may serve as the framework for the storage and later permanent disposal of the nation's civilian and defense nuclear waste. Meeting to receive testimony on S. 3469, The Nuclear Waste Administration Act of 2012, the committee received generally positive reviews of this bill introduced by committee chairman Jeff Bingaman (D-NM).

Bingaman's bill would implement the major recommendations of the Blue Ribbon Commission on America's Nuclear Waste (BRC). Established after the Administration's controversial termination of the review of the proposed Yucca Mountain nuclear waste repository, the BRC called for a consent-based approach to the siting of one or more short term storage sites and geological repositories. Other recommendations included a new congressionally-chartered entity to manage nuclear waste, changes in the use of the nuclear waste fund, and planning for large-scale waste transportation.

Bingaman introduced his bill on August 1 to implement the commission's eight recommendations. Indicative of how deeply troublesome it has been to find agreement on the handling of nuclear waste was the breakdown of a plan to include Lisa Murkowski (R-AK), Dianne Feinstein (D-CA), and Lamar Alexander (R-TN) as original cosponsors of the legislation. These senators are the chairs or ranking members of the Senate authorization and appropriations committees with primary jurisdiction over nuclear waste. The four senators were unable to reach agreement on a legislative mechanism to ensure that a temporary site does not become a permanent storage facility. Almost three months after the bill was introduced, it has no sponsor besides its author.

"With time running out in this Congress, we agreed that I should go ahead and introduce the bill as it stands, and hold this hearing on the bill, and leave it to the next Congress to continue working on the issue," Bingaman said in his opening remarks at the September 12 hearing.

Reviews of S. 3469 were generally positive. In her opening remarks, Murkowski said "Mr. Chairman, the legislation that you introduced is indicative of months of good, productive discussions between you, Senator Feinstein, Senator Alexander, and myself discussing ways to address the back-end of the nuclear fuel cycle. I congratulate you for moving the discussion forward and putting a marker out there toward reaching that goal. While we ultimately could not bridge the issue of linking progress on interim storage and a permanent repository, I want to be clear to those following these discussions that while prospects for legislative enactment [by] this Congress [which will adjourn at the end of this year] are not favorable, we will continue the effort next year and build upon the progress that the Chairman has begun."

Five witnesses provided their perspectives on the legislation. Brent Scowcroft and Richard Meserve served on the BRC and testified that the bill "generally mirrors the Commission's recommendations." They outlined differences between the bill and their report, including the bill's provision that would make the proposed Nuclear Waste Administration a federal agency instead of their recommended federally-charted corporation that, they contend, would "provide a degree of isolation from short-term political pressures."

Of greater significance was whether there should be "linkage" between a storage facility and an agreement on a permanent geological repository. The BRC recommended that there be no linkage. S. 3469 mandates this linkage: "the Administrator may not possess, take title to, or store spent nuclear fuel at a storage facility licensed under this Act before ratification of a consent agreement for a repository. . ."

The bill does make one exception, recognizing a section in the Senate version of the FY 2013 Energy and Water Development Appropriations Bill that was promoted by subcommittee chair Feinstein to establish a pilot plant for the storage of nuclear waste. Bingaman's bill states: "Exception- The Administrator may possess, take title to, and store not more than 10,000 metric tons of spent nuclear fuel at a storage facility licensed and constructed pursuant to a cooperative agreement entered into before the date of enactment of this Act under section 312 of the Energy and Water Development and Related Agencies Appropriations Act, 2013, before ratification of a consent agreement for a repository."

Disagreement about linkage between one or more short-term storage facilities and a permanent repository (similar to Yucca Mountain) was the primary reason why Bingaman's bill does not have additional cosponsors. Bingaman spoke of the need to ensure that a storage facility not become a de facto repository if no agreement is reached on a permanent repository, adding that he welcomes suggestions on how to resolve this matter. Responding to Bingaman's comments, Meserve expressed concern about the bill's severe restraint on opening a storage facility, and predicted that a community agreeing to a storage facility would also consent to a repository.

A third area of disagreement between the bill and the BRC concerned the size and composition of a proposed Nuclear Waste Oversight Board.

While DOE Assistant Secretary Peter Lyons did not endorse the bill, he did not raise any red flags. He spoke of the

Administration's agreement that a new nuclear waste management and disposal entity would be advantageous and that it should have "timely access" to nuclear waste funds. He testified that the Administration supports "the broad scientific and international consensus that a geological repository is the most effective permanent solution to dispose of high level waste." Of note, Lyons said "it is evident that a once-through cycle is appropriate for the foreseeable future." Regarding the importance of a consent-based approach for future facilities, Lyons told the committee:

"No matter what organization, funding, and storage decisions are made moving forward, a consent-based approach to siting is critical to success. The Administration supports working with Congress to develop a consent-based process that is transparent, adaptive, and technically sound. The BRC emphasized that flexibility, patience, responsiveness and a heavy emphasis on consultation and cooperation will all be necessary in the siting process and in all aspects of implementation. Experiences in other countries indicate that a consent-based process - developed through engagement with states, tribes, local governments, key stakeholders, and the public - offers a greater probability of success. DOE is currently evaluating critical success factors in the siting of nuclear facilities in the U.S. and abroad to facilitate the development of a siting process."

Further action on this or any other nuclear waste bill will occur in the next Congress in the form of a new bill. Bingaman, who was elected to the Senate in 1982, will retire at the end of this Congress. When introducing S. 3469 Bingaman told his colleagues:

"The [BRC] commission has performed a very valuable service to the nation in showing us a way forward. Its recommendations merit our careful consideration and deserve our approval. I have attempted to put them into legislative form so that they can be enacted and implemented. I recognize that will not happen this year. It will take a great deal more time and work. But it must begin and I hope it will continue in the next Congress."

Richard M. Jones
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LETTER

My equation-oriented book, *Physics of Societal Issues: Calculations on National Security, Environment and Energy* (PSI) is now available as a paperback for $25 (total cost), which is 15% of the $159 hardback (without shipping and handling). Go to www.springer.com/mycopy when on-campus to purchase PSI. Most universities have a contract with Springer for this my-copy bargain. PSI is now in its second printing, and in the distant future there will be a 2nd edition. It was reviewed in American Journal of Physics [AJP 77, 479 (2009)] and Physics and Society [July 2007, pp. 14-15].

David Hafemeister
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Students Garner Forum Awards for Poster Papers at SPS Conference

APS Forum on Physics & Society Student Poster Award winners at PhysCon. L-R: Jeremy Johnson (Angelo State University), Yulu Liu (Southeast University), Kofi Christie (Morehouse College), Matthew Goszewski (Grove City College), and Allen Scheie (Grove City College). Photo by Ken Cole.

The Society of Physics Students (SPS) 2012 Quadrennial Physics Congress took place in Orlando, Florida, over November 8-10, 2012. The Forum on Physics and Society sponsored three awards for student poster papers: one first-place and two second-place awards for posters which included the societal impact of physics as part of their studies. Of a total of nearly 200 posters, over 90 wished to be considered for the awards. Posters were judged by three different faculty members or trained physics/astronomy professionals. The first-place award was $500 plus complimentary registration at either the March or April APS meeting. The second-place awards were each $250. All three winners also received certificates that featured both the APS and PhysCon logos, and signed copies of one of Lawrence Krauss' popular books. The first place winner was Allen Scheie (Grove City College), and the second-place winners were Kofi Christie (Morehouse College) and Matthew Goszewski (Grove City College). Two honorable mention recipients also received certificates: Jeremy Johnson (Angelo State University), and Yulu Liu (Southeast University, China). We congratulate the winners and their schools.

Abstracts of the winning posters:

The Science Committee: Science Policy on Capitol Hill

Allen Scheie, Grove City College

This summer, I worked as an intern with the U.S. House of Representatives Committee on Science, Space, and Technology, as a John Mather Public Policy Intern. The Science Committee oversees federal science policy, as well as NSF, NIST, NASA, and parts of the EPA, the FAA, and the Department of Homeland Security. As an intern, I assisted with congressional hearings, researched policy initiatives for the committee staff, and built databases. A few of the topics I covered this summer included spaceflight policy, endangered species policy, drought monitoring, hazardous chemical disposal, environmental regulation, and open-access publishing. The purpose of this internship was to get physics students involved with public policy, to develop both scientists who understand policy as well as politicians who understand science. Not only is the federal government is one of the largest funders of basic research, but many problems the United States faces have technical aspects and it is imperative that politicians understand the strengths and weaknesses of the scientific process.

Terahertz Time Domain Spectroscopy of Gold Nanorods

Kofi Christie, Morehouse College

Nanoparticles have distinct electrical and vibrational properties from bulk materials originating from the quantum confinement and surface effect. Bioengineers are currently able to exploit these properties for applications in biosensing, using the surface plasmon resonance wavelength of gold nanorods to monitor changes in their local environment. THz-TDS provides scientists with new opportunities to study low frequency phonons, and low frequency phonons in gold nanoparticles are explicatory of their morphology. Here, terahertz time-domain spectroscopy (THz-TDS) was used to study the vibrational behavior of gold nanorods embedded in a poly(vinyl alcohol) matrix. The nanorods' aspect ratios (diameter x length) of 30.7 x 81.6 nm, 30.7 x 84.0 nm, 16.2 x 39.5 nm, 18.7 x 52.2 nm, and 18.5 x 56.5 nm are confirmed by visible/near-infrared absorption spectroscopy and transmission electron microscopy. The frequencies of the phonon modes are expected to be proportional to the longitudinal and transverse sound velocity in the material and inversely proportional to the size of the Au nanorods. We discuss how THz-TDS offers a solid method to determine nanoparticle morphology.

PhysicsQuest: Bringing Super Powers to Life

Matthew Goszewski, Grove City College

This summer I had the opportunity to intern with the Society of Physics Students and the American Physical Society. I was in the APS Public Outreach department and worked on the PhysicsQuest: SPECTRA comic book. My task was to create demonstrations that middle school teachers would be able to present in their classrooms, using easy-to-find materials, that compliment the physics in the current SPECTRA issue. My Poster will reflect the steps needed for creating a well-written, well -researched, and reliable physics demo.

Nuclear Reactor Safety: Lessons from Three Mile Island and Fukushima

Alexander DeVolpi

[This article is based on a longer article published in the Summer 2012 edition of the Federation of American Scientists Public Interest Report; www.fas.org/pubs/pir/2012.html. *We are grateful to FAS for permission to run an abbreviated version of Dr. DeVolpi's article – Ed.]*

Introduction

All accidents that have involved commercial nuclear-power reactors have ultimately delivered useful lessons about nuclear safety, reactor design, and radiation effects. Despite various power-reactor mishaps [Enrico Fermi Unit 1 (1966); Three Mile Island-2 (TMI-2) in Pennsylvania (1979); Chernobyl in the former Soviet Union (1986); and Fukushima Daiichi in Japan (2011)], the accidents are noteworthy for very few, if any, public casualties. Indeed, it is well-substantiated that neither the TMI nor Fukushima reactor accidents have been responsible for any fatalities to date among the surrounding public. The safety record of nuclear-power, measured in fatalities per unit of energy consumed, is unmatched in the industrial world; coal-fired power plants, for example, have a much higher fatality rate per unit of electricity generated. (The Chernobyl accident, which happened during a safety test, led directly to about three dozen deaths among operators and emergency workers, according to international Chernobyl Forum study reports that have tracked mortality data since the accident [1].) However, these accidents shocked the industrialized world, and they had expensive consequences in terms of cleanups, power loss, decommissioning, and public apprehension. While nuclear safety has improved and important functional lessons have been derived as a consequence of these incidents, more safety systems could have been and could yet be implemented in existing reactors. In particular, a fundamental instrumentation shortcoming that contributed to the Pennsylvania Three Mile Island (TMI)-2 reactor meltdown was never fully addressed in other operating reactors, and that omission might have indirectly hastened Fukushima reactor damage.

At both TMI and Fukushima, accidental loss of water needed to remove residual heat from the reactor resulted in serious damage to overheated nuclear fuel within the reactors' cores. In this article, I review the circumstances of the TMI and Fukushima accidents, and describe some overlooked autonomous nuclear instrumentation that can be installed which would provide independent measures of reactor water level and fissile fuel distribution before, during, and after an accident. I will argue that had operators at TMI been aware that coolant in the nuclear core was below the level and density required for sufficient heat removal, it might have been possible to avert a core meltdown. Similarly, if operators at Fukushima had implemented (or been able to implement) extraordinary emergency cooling measures sooner, they too might have forestalled or mitigated reactor-core damage.

Three Mile Island

At Three Mile Island, two reactors were built in the 1970s in the Susquehanna River near Harrisburg, Pennsylvania. Both were of the pressurized-water type manufactured by Babcock and Wilcox. Construction began on TMI-1 in 1968, and that reactor commenced operation in 1974; it has now operated without incident for over 38 years. The second reactor, TMI-2, suffered its accident after just one year of operation.

The accident at TMI-2 was precipitated when a relatively minor malfunction in fluid flow caused its primary coolant temperature to rise. This caused the reactor to shut down automatically in about one second. A pressure-relief valve then failed to properly shut, but control-room instrumentation did not reveal that failure. As a result, coolant drained from the reactor core, and residual nuclear-decay heat was not removed at a sufficient rate. Worse yet, operators erroneously believed at the time that there was too much water in the pressure vessel, and turned off the emergency core-cooling system. The situation was further aggravated when, after an hour or so of unrecognized overheating, they shut down the coolant pumps.

During the accident, operators and supervisors were unable to diagnose or respond properly to the unplanned automatic reactor shutdown. They had no actionable indication that coolant capacity was insufficient to relieve the dangerous overheating of reactor fuel, nor did they have any information about fluid density while the accident transpired. Instrumentation for monitoring and managing the fission-induced nuclear reaction functioned properly, but means to regulate water-transported power production failed, and no autonomous auxiliary indicators were available to alert operators of the impending disaster. According to the World Nuclear Association, no direct information was available to the operators during evolution of the accident regarding the amount of water within the reactor vessel [2]. Lacking direct water instrumentation, operators judged coolant levels solely by the pressurizer indicator, which advised that water level was apparently high, a consequence of steam buildup in the reactor vessel giving misleading pressure readings. The operators assumed the core was properly covered with coolant. Had they known that water was being lost from the reactor vessel (and that the core was going without coolant), the destructive part of the accident could have been avoided by correct remedial actions. Some external instruments were located on the reactor bridge structure outside the pressure vessel, but those devices could not and did not help diagnose the loss-of-coolant evolution.

Various investigations - such as the Kemeny Commission appointed by President Carter, the Rogovin investigative board, Nuclear Regulatory Commission follow-ups, Department of Energy and UK Chief Inspector reports, Babcock & Wilcox manufacturer improvements, and watchdog groups like the Union of Concerned Scientists - ascribed the TMI accident to deficient control-room instrumentation, inadequate emergency-response operator training, human factors, and user-interface engineering problems. Ironically, "operator error" was cited as a decisive factor in the accident on the rationale that if reactor operators had not erroneously turned off emergency cooling systems, the accident would have been limited. Valuable lessons were learned from TMI, and improvements were advised and implemented in a number of procedural and analytical areas, but, as best as I can determine, no recommendation was made to implement autonomous external water-level instrumentation in either existing or new reactors in any jurisdiction [3, 4, 5]. As I describe below, such specialized equipment, based fundamentally on nuclear rather than conventional sensor principles, would operate in such a manner as to be functionally and physically independent of other instruments and their power sources.

Fukushima

The extraordinary 11 March 2011 Tohoku earthquake of estimated magnitude 9.0 off the coast of Japan caused severe damage to populated areas and induced a tsunami that breached protective seawalls. Up to 20,000 residents are known to have died; 125,000 or more buildings were damaged or destroyed; and there were a multiplicity of secondary effects such as nuclear-plant shutdowns and meltdown accidents near the earthquake epicenter.

The Fukushima Dai-ichi nuclear power station comprises six separate boiling water reactors originally designed by General Electric and maintained by the owner-operator, Tokyo Electric Power Company (TEPCO). Combined electrical power for the station was 4.7 GWe. At the time of the earthquake, units 1 to 3 were providing power at rated output, reactor 4 had been de-fueled, and units 5 and 6 were in scheduled cold shutdown for maintenance. In response to the earthquake, control rods deployed, and the operating reactors automatically shut down. When external electricity was lost, emergency diesel generators started up properly and many other instruments also functioned as designed, although backup electrical supply was insufficient for the reactor pumping systems. However, about an hour later, the tsunami overwhelmed ocean-facing barriers and broke connection to the power grid, resulting in flooding of sub-grade rooms containing emergency generators. Those generators consequently stopped working, and pumps that circulate coolant water in the reactor ceased to work, causing the reactors to begin overheating. Operators were still engaged in post-shutdown procedures such as controlling reactor pressure with limitations not to exceed an established cool-down rate. The flooding and earthquake damage greatly hindered external assistance. Contrived remedial measures, including injection of ocean water, were not sufficient to prevent partial or full core meltdown in the three reactors that had been in operation. Flooding also lead to failure of secondary systems and to dramatically destructive explosions in three reactor buildings; volatile gases had originated inside the reactors after zirconium fuel cladding reacted chemically with coolant water to produce a buildup of explosive hydrogen. In addition, radiation escaped reactor containment, polluting the land, sea, and air environment.

The reactor water level in Fukushima unit 1 is considered to have receded within a short period of time, leading to exposure of the reactor core and to core damage. Reactor pressure decreased even though no actions were taken to reduce it. On the other hand, pressure within the containment vessel increased, implying that reactor-vessel pressure could not be maintained due to stresses on the vessel, and that the core damage had advanced a considerable extent within a short period of time. For Units 2 and 3, reactor water level started to decrease after cooling circulation stopped. Fire-engine pumps were started and low-pressure water injection was ready, but it could not be started quickly enough. The amount of water in the reactors sharply decreased. This resulted in core damage, for unit 2 about two hours after the earthquake, and for unit 3 after about 60 hours. Because of the extraordinary conditions, boric acid and seawater were injected into the unsalvageable reactors in order to quench possible nuclear recriticality, in which a reactor might spontaneously renew production of a fission chain reaction that cannot be properly cooled or safely contained. Such nightmarish scenarios are more conceptual than realistic, but properly informed measures are needed to cool, control, and manage the residual cores until they are fully decommissioned.

At this writing, the condition of Fukushima units 1, 2, and 3 is relatively static, but those reactors have yet to achieve a stable, cold shutdown. This means that they could still undergo various and uncharted stages of self-destructive disassembly and meltdown. These reactors could thus still benefit from diagnostic information specific to (1) their existing, but unknown, post-accident coolant level, (2) the current status of undetermined core fuel redistribution, and (3) any other changes that might yet take place in time. The responsible managers simply don't know how much water is in the pressure vessels, nor do they know where the nuclear fuel is now located. Although nominally out of operation, these three reactors still generate many megawatts of heat and radiation, and considerable risk remains of further potentially harmful degradation of their components. Most uncertain is the ongoing condition of the nuclear core and its water coolant, a continuously changing and currently indeterminate situation. Because normal water supply was interrupted by failure of electrical pumps and other emergency measures, extraordinary methods are currently being used to supply sufficient water coolant for the three damaged reactor vessels. Forced external cooling will probably be necessary for many years.

The Case for Coolant-Level Monitoring

Some factors that caused internal reactor damage at Fukushima were similar to the accident at TMI in the sense that (1) the hot reactor core was suddenly deprived of sufficient water coolant, and (2) ad-hoc measures had to be undertaken to provide emergency cooling. Because of insufficient coolant, and despite improvised emergency measures, three Fukushima reactors experienced internal fuel meltdowns that destroyed their nuclear cores. The molten core debris was fully and safely contained within the biological shield of each respective reactor, however.

When the Fukushima-reactor cleanup staff and crew is ready to plan and engage in removal of fuel and core debris, it would be extremely valuable, and probably essential, to have updated knowledge of the approximate quantity and geometrical distribution of water and fuel inside the reactor pressure vessel. Such information would help safely and economically manage residual nuclear-criticality and radiation-exposure risks for each disabled reactor.

External instrumentation has been designed and patented that could be introduced for the specific purpose of determining in real time how much water is currently within the reactor vessels. Such instrumentation can be placed inside the reactor containment building, but outside the pressure vessel. For example, this author has developed and patented a proposal for such an instrument that could be installed and operated remotely, based on a modified "fast-neutron/gamma-ray hodoscope." [6] This equipment was conceptualized as a result of the TMI accident, and was formalized in a U.S. patent issued in 1987. Had this instrument system already been installed at the TMI-2 reactor, it is likely that the accident could have been averted, and implementation at Fukushima could yet assist in preventing further damage by removing uncertainty regarding the ongoing nuclear-fuel condition and water-coolant status. Such a system could collect data for years after a reactor has nominally ceased operation. The same instrumentation, if based on measurement of penetrating radiation, can also be used to map the physical arrangement of the intact and/or crumbled reactor fuel. Such information would be important in safe and methodical dismantlement, which might take up to ten years. Much of this is now cleverly being deduced from indirect instrument data and analysis.

The term "hodoscope" refers to a calibrated set of radiation-detecting instruments that differentiate the direction and energy of selected nuclear radiation. Fast neutrons and gamma rays are forms of penetrating radiation that originate inside nuclear reactors, whether operating at full power or closed down after a long history of operation. Residual radiation emerging from the now-inoperative reactors provides a way to measure the existing quantity and distribution of water and

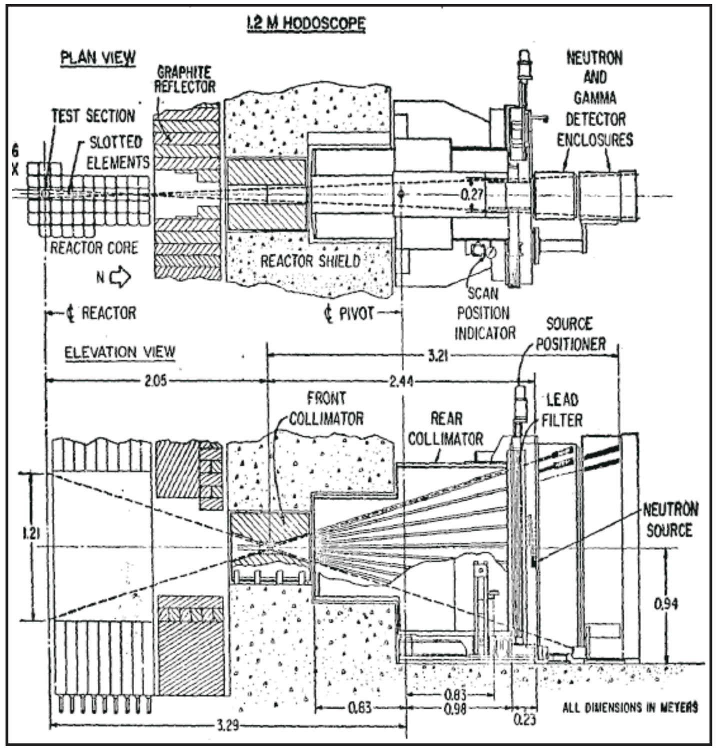

Figure 1: Top (upper) and side (lower) schematic illustrations of a hodoscope.

fuel in the reactor. Figure 1 shows cross-sectional and side views of a hodoscope that has been tested at the Transient Reactor Test (TREAT) facility at the Idaho National Laboratory. The basic premise of this device is that a neutron source and target are placed inside the reactor core; detecting apparatus is installed with the reactor's biological shield, and the remainder of the data storage and electronic systems are placed outside the reactor shield (Figure 2). In both the United States and France, hodoscopes have been installed in a manner similar to that shown in Figure 2, and have rendered time-resolved image reconstruction of fuel and coolant that have been subjected to severe test conditions. A more recent patent is directed particularly at Fukushima, and is based on the idea of equipping the reactors with autonomous, remotely-operated sensors located inside reactor biological shields. Implementing this invention could take two manifestations: a system of mobile detectors which would be introduced through the airlock onto each reactor floor, adjacent to but external to the reactor pressure vessels, or a system of permanent detectors installed by means of narrow penetrations through the biological shields. Of course, a major limiting factor will be safe and practical access to requisite areas inside the reactor building.

The diagnostic system proposed here has a solid foundation in prior research, development, testing, and supportive calculations, but has not as yet been actually assembled and tested in a water-cooled power reactor. An evaluation program is under consideration in the Nuclear Engineering Division of Argonne National Laboratory and proposed to the U.S. Department of Energy.

Discussion and Summary

Although the worldwide nuclear industry has implemented and touted higher levels of safety, reliability, reactor improvements, and training in the operation of plants since the accidents described here, apparently little has been done to provide supplementary external instrumentation. Indeed, belatedly, and without authorizing relevant action, an official 2004 NRC Fact Sheet on the Accident at Three Mile Island acknowledged explicitly that "There was no instrument that showed the level of coolant in the core" [7]. More recently, a 2011/2012 NRC Task Force Review of Insights from the Fukushima Daiichi accident failed to make recommendations dealing with the gamma hodoscope instrumentation previously discussed in this paper [8]. In the 30-plus years since the TMI event, no operating reactors have been retrofitted with failure-resistant autonomous water-level instrumentation positioned external to the pressure vessel.

Plausible explanations for omitting bulk water monitoring are that such an objective was deemed technically too speculative, too difficult, or too intrusive to achieve. Given the vast array of monitoring devices already built into reactors, however, these should not have been overwhelming objections; also, the cost of providing such instrumentation should have been but a small fraction of the capital cost of a reactor. Somewhat incongruously, as a lesson-learned from the Fukushima accident, NRC is advocating autonomous water-level instrumentation only for spent-fuel ponds, but not for the reactors themselves.

I firmly believe that it is not too late for the disabled Fukushima reactors to benefit from post-hoc introduction of diagnostic monitoring equipment such as I have described here, nor is it too late to develop and test such proposed systems for a role in commercial power reactors throughout the world.

Damaged reactors must be gradually and safely shepherded into a condition known as "cold shutdown" before being disassembled and decommissioned. For TMI, the post-accident stage required about ten years, and substantial effort, cost, and the development of special decommissioning technologies. For the Fukushima reactors, it would be wise to anticipate and implement technical measures based on the TMI experience. The hazards of core meltdown and subsequent decommissioning might further be minimized by some selected remedial measures and precautions that could be implemented.

The title of this article was chosen deliberately to emphasize the safety of commercial nuclear power. But just as important as controlling the nuclear reaction is the necessity of safely dealing with water-transported heat. I have outlined autonomous external nuclear instrumentation that can independently measure reactor water level and fissile fuel distribution before, during, and after a reactor accident or routine shutdown. I encourage nuclear regulators and utilities to consider adopting autonomous water-level and fuel-concentration monitoring systems for both existing and planned reactors.

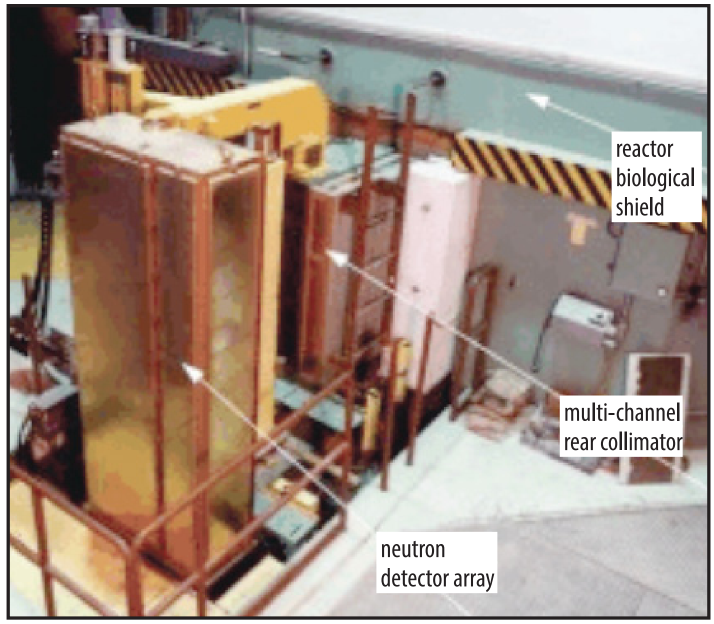

Figure 2: Photo of hodoscope installation outside the TREAT reactor.

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Dr. Alexander DeVolpi's research and development work in reactor safety grew in part from active military service in the U.S. Navy, followed by assignments as a Reservist at the Naval Research Laboratory in Washington, DC, and the Naval Radiological Defense Laboratory in San Francisco. This affiliation lead to specific applications in reactor-safety research and instrumentation later developed at Argonne National Laboratory, near Chicago, Illinois, and utilized at the Idaho Nuclear Engineering Laboratory. In later years at Argonne, he moved on to applications involving arms control and treaty verification, which included technical assignments from the Defense Nuclear Agency and professional collaboration with many non-government organizations.

The Nuclear Emergency Support Team (NEST)

Cameron Reed

[This article is based on a presentation titled "Don't Mess With the NEST," which Dr. Michael O. Larson gave in a session on "New Developments in Radiation Detection Technologies & Nuclear Security" at the April 2012 APS meeting in Atlanta. We thank Dr. Larson for providing the Figures. – Ed.]

Introduction

The Nuclear Emergency Support Team was formed in 1975 in response to various domestic nuclear extortion threats. The mission of NEST is to conduct, direct, and coordinate search and recovery operations for nuclear material, weapons or devices, and to assist in the identification and deactivation of Improvised Nuclear Devices (INDs) and Radiological Dispersal Devices (RDDs). To this end, NEST builds and stores equipment and maintains 24/7 deployable response teams at various locations around the United States, ready to respond to incidents. In this article, I will review the history of NEST, describe some of its deployments and exercises, and review its current operational configuration, which includes a Nuclear Threat Credibility Assessment Program, Radiological Assistance Program teams, and Joint Technical Operations Teams. As one might expect for such an agency, there are close connections to a number of government departments and national laboratories; a list of acronyms appears in Table 1.

Table 1. Acronyms

CONUS	Continental United States
DoD	Department of Defense
DOE	Department of Energy
EG&G	Edgerton, Germeshausen & Grier, Inc.
IND	Improvised Nuclear Device
JTOT	Joint Technical Operations Team
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
NNSA	National Nuclear Security Administration
NRAT	Nuclear/Radiological Support Team
OCONUS	Outside Continental United States
RAP	Radiological Assistance Program
RDD	Radiological Dispersal Device
SNL	Sandia National Laboratory

Origins of the NEST

The origins of the NEST go back to 1970, when the mayor of Orlando, Florida, found on his windshield an extortion threat typewritten in red. It claimed that a "nuclear fission device" involving uranium-235 was hidden in the city; the perpetrator(s) demanded money and safe passage out of the country. The scientific contents of the note were garbled, but a subsequent handwritten note – which bore a return address – contained a drawing of the alleged device, which an "expert" deemed roughly accurate. The Atomic Energy Commission had no protocol for dealing with such situations; the police had to take the threat seriously. The return address was that of an abandoned house, but neighbors told investigating officers that a boy would periodically come by to mow the lawn. The boy's handwriting proved identical to that in the second note; he was arrested (age 14), and the threat was revealed to be a hoax.

Further early-1970's threats – all hoaxes – prompted Fred Jessen of LLNL to decide that a response capability to deal with possible terrorist nuclear threats was necessary. Jessen established Project Warmspot, which involved a search van equipped with various radiation-detection instruments. In May, 1974, a threat received in Boston prompted the FBI to seek technical assistance, and LLNL, LANL, and EG&G responded by deploying experts under the direction of an AEC official. The Boston incident was also a hoax, but pointed up the need for a national-level threat-response capability, and in November, 1975, Project Warmspot was incorporated into the multi-agency Nuclear Emergency Search Team under the auspices of the AEC, which assigned its Nevada Operations Office to oversee the group. Based on authority granted by the Atomic Energy Act of 1954, the lead federal agency in domestic NEST-related investigations is the FBI. Today, NEST is housed within the Department of Energy's National Nuclear Security Administration.

Exercises and Deployments

Between 1975 and 1994, NEST mounted some 30 exercises and deployments. The first major exercise was NEST77, which was held at the Idaho National Engineering Laboratory. This involved a sophisticated IND designed and built by LLNL. This exercise involved a number of organizations: the FBI, Department of Defense (DoD), LLNL, LANL, SNL, EG&G, and the National Atmospheric Release Advisory Center (at LLNL) which worked to predict a fallout pattern if a detonation had occurred; NEST carried out diagnostic, device assessment, and disablement exercises. An exercise held in 1980 in New Mexico was performed as if it was occurring on foreign soil; since it was "outside" the continental United States (OCONUS), the lead federal agency was the Department of State, not the FBI. Another exercise held in New Mexico in 1984 was configured to simulate a low-profile search for the notional IND in a major city. This exercise marked the first time that a foam-filled containment tent, which could contain debris from the detonation of the high explosives, was erected. A 1986 exercise simulated an OCONUS device plus a second device planted in a Midwest American city, necessitating participation from multiple federal agencies and state and local officials; NEST deployed teams to both sites. In this case, a notional detonation was played at the CONUS site, and FEMA exercised "Consequence Management." Another major exercise staged in California in 1988 was designed to test interagency operations, and involved a notional attack on a convoy where a US weapon was stolen and hostages taken. Search, hostage negotiations, and render-safe operations were performed. A 1994 exercise in New Orleans involved some 850 participants, and received significant public exposure via a segment on the popular television program "Behind Closed Doors" hosted by Joan Lunden, and a cover story in Time magazine titled "Nuclear Ninjas" (January 8, 1996).

Figure 1: Operation Morning Light, 1978.

One of NEST's first true deployments occurred in southern California in 1975, in response to a device threat at Union Oil. Nothing was found, but the deployment was useful for establishing procedures. A large-scale real-life deployment was Operation Morning Light, which was mounted in response to the crash of the nuclear-powered Soviet Cosmos 954 reconnaissance satellite in northern Canada in January, 1978, depositing debris over a 600-kilometer path. The Canadian government requested help from the United States, and NEST deployed an extensive array of search equipment. Morning Light involved covering, by foot and air, an area of some 124,000 square kilometers (Fig. 1). Twelve larger pieces of the satellite were recovered, all but two of which were radioactive. These pieces displayed radioactivity of up to 1.1 sieverts per hour, and one fragment has been claimed to have had a radioactivity level of 5 sieverts per hour; the normal maximum annual recommended per-person dose level is 5 sieverts per year. The Canadian government billed Russia for $6 million for the cleanup, and received $3 million [1].

Figure 2: Harvey's Casino bomb and the result of attempted disarmament.

In August, 1980, a very sophisticated bomb containing 1,000 pounds of dynamite was found at Harvey's Casino, in Lake Tahoe, Nevada. The FBI and bomb squads were unprepared, and an attempt to disarm the bomb caused it to detonate (Fig. 2). No one was injured, but the event caused the NEST's mission to be modified to include dealing with "sophisticated improvised explosive devices (SIED)."

The Nuclear Threat Credibility Assessment Program

Since 1970, there have been some 350 instances of domestic nuclear extortion threats (stolen weapons, IND, RDD, or threats to attack a reactor), virtually all of which have been hoaxes. As mobilizing to each threat would be costly and represent a vast waste of resources, Fred Jessen formed, in 1978, the Communicated Threat Credibility Assessment program (CTCA), which was later renamed the Nuclear Assessment Program (NAP). This program, which has a Communications and Coordinating Center at LLNL, is tasked with assessing whether or not claims are credible from the points of view of behavioral resolve, technical feasibility, and operational

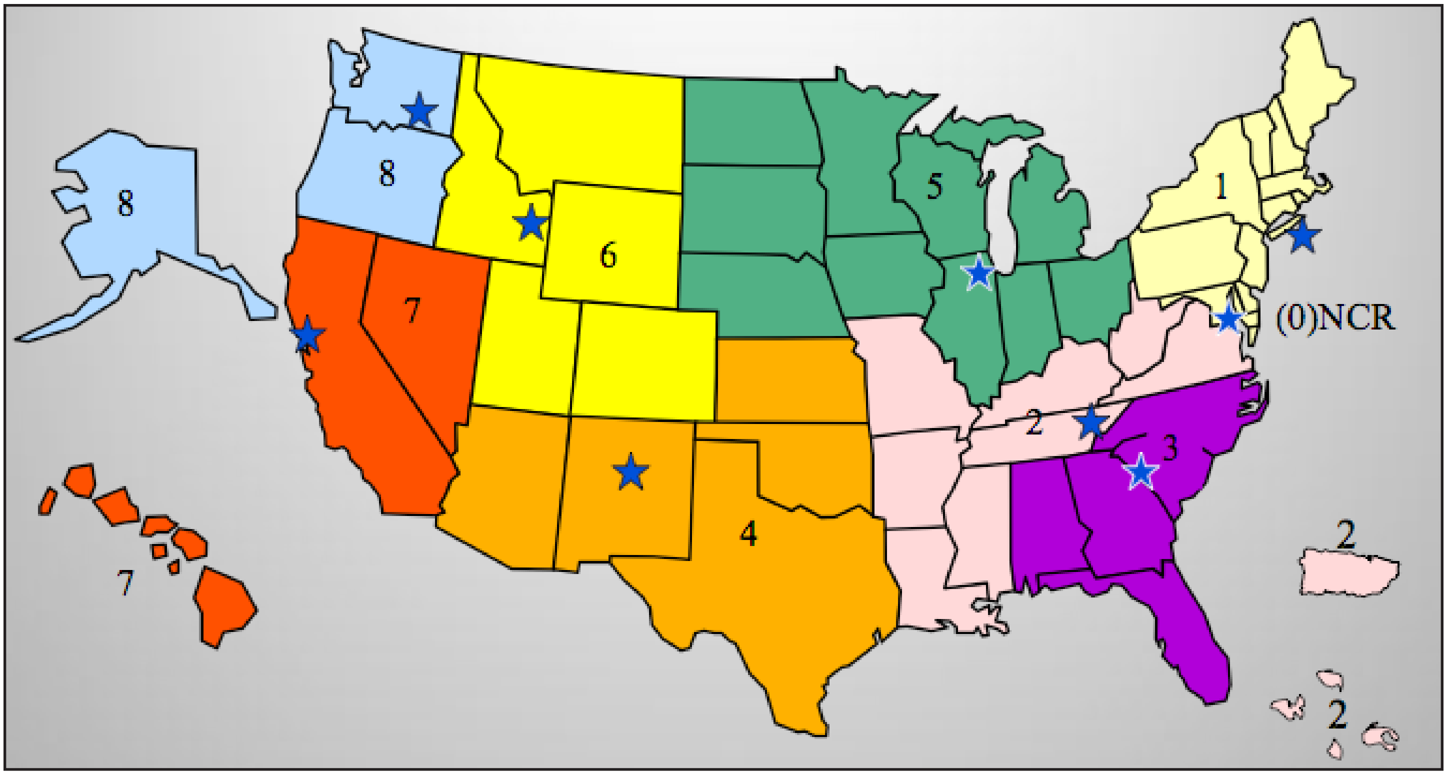

Figure 3: Map of Department of Energy Radiological Assistance Program geographical areas. Region 0 is the National Capital Region.

practicality. Two teams are always employed to cross-check conclusions, with advice as to the necessity of deploying resources (or not) then being transmitted to decision makers.

Following the 1994 exercise in New Orleans, NEST was restructured. The name NEST was maintained but instead of the Nuclear Emergency Search Team it became the Nuclear Emergency Support Team. It was reorganized into three elements: the Nuclear/Radiological Support Team (NRAT), Search, and the Joint Technical Operations Team (JTOT). NRAT has domestic and foreign support teams which deploy from Washington to advise local authorities, and provide a rapid-response capability to provide preliminary information for follow-on groups. The Search group deploys specialized capabilities to address the problem of finding a radioactive threat object. JTOT incorporates what was essentially the operational capability of the original NEST, and is responsible for deploying specialized technical capabilities, instruments, and people who are charged with rendering objects safe and subjecting them to analysis and disposal.

The JTOT teams are composed of scientists and technicians from various DOE laboratories as well Explosive Ordnance Disposal (EOD) team members.

Incident Response, and the Current Status of NEST

What happens if a credible threat is received? First on the scene may be a Radiological Assistance Program (RAP) team, deployed from one of the nine United States RAP regions from which the threat originates (Fig. 3). Data from Police, Fire, Customs, and RAP personnel who carry spectrometers and radiation-detecting equipment is fed to LLNL, LANL, and SNL, who have staff on-call 24/7 to analyze the data and provide advice to the DOE and NNSA. If it is concurred that a device is of interest, a JTOT team will be deployed. If radioactive material is apprehended, a nuclear forensic analysis will be carried out to characterize it.

America can feel secure that any nuclear threats will be dealt with promptly and effectively. NEST continues to leverage and support research and development at national laboratories to develop instruments to diagnose and disable threat devices, and maintains teams at constant readiness through a program of exercises that involve physical deployments of emergency response personnel to various locations. Deployments can be no-notice, where on-call team members must be able to get to their home center and then deploy rapidly, without prior knowledge. "Don't Mess with the NEST" ! They are ready!

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Who Speaks for Science? Experience from Canada

Rees Kassen

On July 4, 2012, research teams at CERN in Geneva announced the discovery of a particle having all the hallmarks of the Higgs boson. The announcement was made cautiously, but with an obvious sense of excitement. This was big news. By all accounts, we now had experimental confirmation that the last remaining particle in the standard model's menagerie of the most basic components of matter might actually exist. The story went viral. There was talk of 'the God particle,' the Twitterverse came alive with boson-jokes, and many heralded a new age for physics.

To be fair, the hype did get out of control from time to time. Many pundits predicted, incorrectly for the moment at least, a Nobel Prize for CERN and Higgs. Others, like Dan Gardner from Vancouver's The Province newspaper, questioned the value of the whole endeavor: 'People are starving, Earth's a mess, and our best minds are doing what?' was the headline. In the meantime, the geek media did their level best to explain the importance of the results and to justify why it all matters in the first place, to anyone who cared to listen.

But who is this so-called anyone? Or, more precisely, who is listening when science speaks? For an answer we can turn to science journalists, since their livelihood depends on them knowing their audience. John Rennie, former editor in chief at Scientific American, commented once that people read either because they have to, for work, or for entertainment. This is equally true in science, which means that the 'anyone' following the Higgs story is either, to a first approximation, a scientist or an already-committed consumer of science stories.

Higgs may have been unusual in the amount of attention it received for a science story. It is, after all, hard to resist a story about the God particle. For the majority of science stories, though, the only people paying attention are, for the most part, those who would have paid attention anyway. If this is true for the public at large, it was also true for one small but extremely important segment of that public: the elected officials who represent them. It is no surprise, then, that scientists are often frustrated in their efforts to get a fair hearing in decision-making and public affairs: there is no one at the other end who is listening to them.

The question is, what to do about it? Here I offer some reflections on the disconnect between scientists and elected officials, and discuss approaches currently underway in Canada to help bridge this gap.

Science walks into a bar and no one notices

A good part of the problem is that, with the exception of a few high profile figures and issues, science has effectively zero visibility among politicians. They are simply too busy to pay much attention. I have heard it said that in Canada, at least, Members of Parliament (MPs) spend up to 50% of their time dealing with just a single constituency issue – immigration appeals – on top of their regular parliamentary duties. When you add in travel between their constituency itself and the seat of government in a physically large country, there is precious little time left over to devote to understanding the intricacies of any issue, scientific or otherwise.

It is also the case that many are not trained in science. Canada's House of Commons has just 17 of 308 sitting MPs with at least a first degree in the natural sciences, engineering, or health sciences, according to the Canadian government's PARLINFO website. Most of the rest come to public life from a background in small business or law. But by itself this number is meaningless. Is 17 large or small? Well, consider this. If one uses nation-wide graduation rates in these disciplines as a guide, we would predict something like 98 MPs to have a science background. There is clearly a deficit here in the receptivity of the political class to science.

Scientists, for their part, seem reluctant to do their part. Most of us got into science out of a fascination for research and a love for knowledge. A mud-slinging political life was not for us. We also have a tendency to be accurate and comprehensive with our advice, rather than to the point and persuasive as is often needed in political life. And sometimes science seems to bear a heavier burden in the public eye for getting things wrong, as the recent conviction of six leading geoscientists in Italy for failing to give adequate warning about the chances of a major earthquake attests.

And to top it all off, we have a hard time letting go of our labs to participate in public life. The Canadian House of Commons has just one MP with a PhD in science, for example. The same is true of the UK, as David Adam of The Guardian reported earlier this year. The last US House of Representatives (2008-12) fares somewhat better, with eleven according to the website hillwho.com.

So, not only are most elected officials not trained in science, they do not regularly work alongside scientists as colleagues or interact with them as friends. Perhaps it is no surprise, then, that contrary to what most scientists might wish or think, science does not have any sort of preferred voice in decision-making. We have not cultivated an audience that is receptive to it. At best, politicians see us as a lobby group, just like any other. Science, and more generally evidence, clearly faces an up-hill battle in the halls of legislative power.

It starts with us

One of the biggest obstacles to cultivating a better relationship between decision-makers who use evidence and the researchers who collect and create it can be scientists themselves. I know that this statement goes against the grain of what most scientists think. But consider this. A study released last year showed that scientists tend to blame poor policy decisions on a scientifically illiterate or uninterested political class and a media that oversimplifies complex ideas or unfairly sensationalizes controversy [1].

In other words, the problem is them, not us. If only, the thinking goes, politicians understood science better they wouldn't make 'wrong' decisions. But this misunderstands the problem entirely. Poor scientific decisions in politics are not necessarily a result of a lack of understanding. They are a lack of time and, more worryingly, motivation. Peter Calamai, former science-reporter for the Toronto Star, once remarked that it is one thing for the non-science public to not understand what the standard model in physics is. It is quite another, potentially more damaging, that the vast majority of people feel it doesn't matter they don't know. The same applies to our elected officials.

What we need is a new way for scientists to engage with elected officials. Simply stating the facts doesn't work. Scientists need to recognize and accept that, at the end of the day, they are playing politics.

The PAGSE approach

For the past three years I chaired the Partnership Group for Science and Engineering (PAGSE) – an association of science and engineering societies that provides the consensus opinion of the research community directly to the Canadian federal government. We estimate that we represent somewhere on the order of 50 -60,000 researchers who, by virtue of their membership in a professional society, are members of PAGSE. Our membership comes from all sectors of research life including academia, government, and industry.

PAGSE undertakes a number of initiatives designed to engage parliamentarians in discussions on scientific research. Probably our most important activity is to submit a Brief to and testify before the House of Commons Standing Committee on Finance, which makes recommendations on budget spending to Cabinet. Our aim is not to lobby on behalf of any particular group or issue, but rather to explain to lawmakers what investments in research would best serve the country as a whole.

We also meet regularly with top civil servants responsible for government departments that have science as part of their core mission. These meetings are tremendously important and valuable, on both sides of the table. The departments, after all, are the ones feeding advice directly to the Ministers. It is therefore important for us to know what their priorities are and the challenges they face. In turn, PAGSE provides a ready national network that the bureaucrats can access, if necessary, for expert opinion and advice.

We also run two education projects. One is our flagship Bacon & Eggheads program, a breakfast seminar series where top-flight researchers address Parliamentarians, their staff, the media and bureaucrats on scientific issues in their field. We work hard to identify excellent researchers who are also outstanding communicators on topics that are of current relevance to the political and legislative agenda of the day. The speakers make their presentation over breakfast – before the work of Parliament begins in earnest for most MPs – and we allow ample time for informal discussion and interaction before and after the presentation. Bacon & Eggheads thus provides a space for parliamentarians and researchers to interact, face-to-face in an apolitical atmosphere.

The other is a newer project called SciencePages where we aim to increase discussion on topical issues having science at their core by summarizing, briefly and in accessible language, the current state of knowledge and policy. Each issue is prepared by a team of three interns – one each from science, policy, and communications – peer-reviewed by experts in both science and policy, and distributed to Parliamentarians and the public. This approach has the advantage of filling two important gaps in the Canadian science-policy landscape. One is the need for short, readable, and, above all, credible notes on science-related issues. The other is the opportunity for the vast pool of young, talented, individuals interested in science and policy to get hands-on experience working at the interface between these two disciplines.

PAGSE has had an impact, at least on the side of improving the landscape within which research is done in Canada. Although it is rarely possible to know the inner workings of government decisions, many of PAGSE's recommendations have at least been in tune with recent actions. Examples include the creation, in 2010, of an internationally competitive postdoctoral fellowship program and, in 2011, increased support for international training and research. These were both suggestions that came, in part, from PAGSE.

In the shadow of evidence

PAGSE has established credibility amongst policy-makers in Canada. Its work happens quietly, behind the scenes. We try to work with the government to improve the climate, on behalf of Canadians, for research, innovation, and evidence-based decision making. Because it is not a lobby group, it also does not criticize. This means it has to be careful of what it does and does not say. There is a fine line between providing a consensus opinion and lobbying, and PAGSE works hard not to cross it.

This means there is a limit to what PAGSE can do. PAGSE has been most effective when it speaks on 'policy-for-science' initiatives aimed at improving the climate for research and innovation. Successes have been harder to come by in the other direction, on 'science-for-policy' perhaps because there are too many ways in which statements can seem partisan, especially when it comes to the environment and sustainable resource use. Recent government decisions weakening habitat protection for fish species and environmental regulations on resource extraction are a case in point.

There may be room here for a more vocal, pro-active approach, one that can hold the government to account on issues regarding the use of evidence in decision-making. If so, it won't be PAGSE who will take up the charge. Some other institution or organization will have to step up to do this work. In some countries this is the role played by national academies or other groups, such as the AAAS, that take on the mantle of being advocates for science. In Canada, despite numerous attempts over the years, no one organization has emerged to fill this gap.

The situation may be changing, however. Last July, close to 2000 scientists, all dressed in lab coats and carrying a casket into which was delivered reams of data, text books, and other paraphernalia of the scientific life, marched through the streets of Ottawa to Parliament Hill. They staged a mock funeral eulogizing the 'death of evidence' in decision-making by the federal government and the muzzling of government scientists.

By most accounts the event was a success. Nature ran a lead editorial on the march, noting, in a direct message to the federal government, that, "scientific expertise and experience cannot be chopped and changed as the mood suits." Perhaps as a result, when a government plan to pipe bitumen from the tar sands of northern Alberta to the British Columbia coast came under fire, it was the Prime Minister, Stephen Harper, who announced that the decision on where and how to construct a pipeline would be based on science. This is significant. That it was the PM who made the statement and not, as would normally be the case, one of his Ministers, is a signal that the government heard what the marchers were saying.

A place for science in politics

The leading challenge confronting scientists is not the quality of our science, it is the receptivity of decision-makers to that science. There is a sense shared by many around the world that the level of receptivity is worryingly low. The triumphs and hopes of science are not their triumphs or hopes.

Scientists have to shoulder some of the blame for this situation. For too long we have seen ourselves as above the fray of politics, with the result that we have effectively removed ourselves from the decision-making process. This cannot continue.

We need to be willing and effective communicators with civil society and decision makers. The aim here is to increase the receptivity of the political class to science, so that when the time comes to make decisions, science gets at least a fair hearing. PAGSE, with its quiet, non-advocative approach, is one way of doing this. A more pro-active, responsive approach such as the activism of this past summer's march on Parliament Hill may be another. No doubt a combination of both is worthwhile, and the challenge for the future will be to strike the right balance between the two.

Reference

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REVIEWS

Switching to Solar: What we can learn from Germany's success in harnessing clean energy.

Bob Johnstone, Prometheus Books, New York 402 pages (illustrations). ISBN 978-1-61614-222-3. Paperback: $19 (6" x 9").

Two of the biggest environmental issues looming over us, probably thought about far less than they should be, are global climate change and the decline of fossil fuels. Of course these two issues are tightly coupled to each other; every liter of oil burned is 3 kg of carbon dioxide in the atmosphere and one less liter of oil available. With 1 kW of solar energy arriving per square meter at the orbit of the Earth, solar energy is clearly the principle way forward from fossil fuels. As physicists, we go back to this very important number again and again: solar power is THE source of energy on Earth. It is the energy that drove the photosynthesis that grew the plants that turned into the oil. It is the energy that drives the winds and ocean waves, the other potential sources by which we can extract that energy in a sustainable manner.

Switching to Solar: What we can learn from Germany's success in harnessing clean energy looks closely at a practical model of how to make this transition from carbon dioxide-emitting fossil fuels to solar power. Germany, a cloudy, northern latitude nation, would not at first seem an obvious place for a major investment in solar electric power. But the German government was willing to lower the bar to entry by way of solar investment credits and electrical buy-back guarantees.

Since this book appeared a year ago, a lot has happened in the field of solar power. Solyndra has gone from a proud example of US manufacturing to a political football, and even a symbol of failed renewable energy dreams. The company lost $534 million and 1100 jobs when it failed. It had accounted for about 1.3% (either "only" or "fully" depending on your view) of the Department of Energy's loan portfolio. (Of course, the US has funded renewable energies at a much lower level than most other industrialized nations.)

Meanwhile also, the European economy (and in fact the European Experiment) has run into troubles. In the wake of the Fukushima disaster, Germany is in the process of shutting down nuclear power plants in favor of Russian natural gas. And more directly relevant to the discussion here, European nations are ending financial support for new solar installations. Part of the argument, in addition to the simple cost basis, is that the program has been a financial conduit not just to German solar manufacturers and installers, but primarily, and increasingly, to Chinese solar panel manufacturers. German subsidies of the solar industry are in rapid decline. It is probably too early to tell if the breakdown of the German solar resolution (or experiment) is short-term or not. Perhaps when economic times are better, there will be a return to the subsidies that help the solar industry start up. After all, there are government supports as well for the natural gas pipelines too.

The author, Bob Johnstone, is a journalist based in Australia who notes how few solar installations there are in one of the world's sunniest nations. The factors which separate the solar explosion in Germany from the quiet acceptance of coal-burning in Australia are political will and a sensible economic setup. The German government provided a feed-in tariff; in essence, they guarantee that your electrical retailer will purchase your power at a rate sufficient to pay back your initial costs and provide you with a good return. It is a good deal on the government and electrical utility end if, and only if, the real price of electricity will increase in the future, perhaps due to a scarcity of fossil fuels. In the short term it is expensive, however.

With fracking, a renewed push for cheap natural gas exploitation, and difficult economic times, the economic proposition no longer looks nearly as good as it once did for these feed-in tariffs. How quickly things change…

The book lays out the case for a German model of feed-in tariffs as a sensible route towards a post-fossil-fuel world: making an investment now for an installed solar base when it is needed. Although the plan has run afoul of bad economic times and the difficulties of managing financial incentives aimed at local businesses in a worldwide economy, we will undoubtedly be looking seriously again at these plans in a few years. In the meantime, it is a worthwhile read for a practical look at government-industry cooperation leading to roofs of power-generating panels.

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