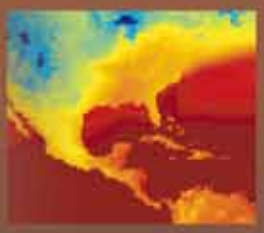
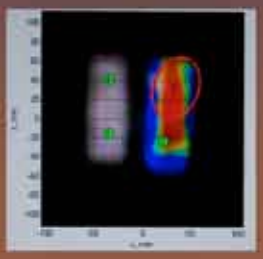
NNSA LDRD Tri-Lab Symposium 2009



Innovation for Our Nation



Strengthening America's Infrastructure Security

Symposium Proceedings

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On August 19, 2009, in Washington, DC, principal investigators, managers and other interested parties from the NNSA's Laboratory Directed Research and Development (LDRD) program convened an open Symposium to review program highlights and discuss program initiatives and directions. The symposium focused on R&D in the area of critical infrastructure security, that is, projects seeking to strengthen America's position in areas such as emerging energy technologies and energy storage, climate change impacts, cyber security, border security, and biosecurity. Participants included staff from the three NNSA national laboratories (Sandia [SNL], Los Alamos [LANL], and Lawrence Livermore [LLNL]), the Nevada Test Site (NTS), the four weapons manufacturing plants (Pantex, Y-12, Kansas City, and Savannah River), as well as from other federal agencies and interested organizations, including general and science news media, and even representatives of the Russian and British embassies.

Out of the Box Research

Jamileh Soudah, NNSA

Opening the Symposium with the appropriate overview of innovation, NNSA Joint Programs Director, Jamileh Soudah, hearkened back to the Manhattan Project in characterizing the three NNSA laboratories as having a heritage of pioneering "out of the box solutions" to hugely complex problems, and therefore completely well-equipped to tackle the complexities of infrastructure security. She cited instances in which weapons work and its spinoffs resulted in programs that later became current-day Laboratory initiatives. Soudah emphasized the commonality in LDRD, SDRD and PDRD programs, the goal of each being the pursuit of high-risk solutions to national exigencies, and she reviewed the 1991 congressional legislation that was aimed at ensuring the broader national security mission of the LDRD Program, a mission extending far beyond nuclear weapons issues. With respect to program specifics, she cited the competitive nature of funding, only about 10% of ideas ultimately funded, the relevance of projects to mission, the long-term focus of much of the research in approaching scientific fundamentals, and the importance of LDRD to attracting and retaining the best-and-brightest staff. Within those contexts, Soudah reviewed the scope of the day's scientific poster presentations subsuming the various areas of critical infrastructure security.

"LDRD projects push the envelope, pursuing out-of-the-box solutions to improving infrastructure security."

The Future of Mankind — The Issue of This Century

William Brinkman, DOE/SC

Characterizing himself as "a big fan of the LDRD program," DOE Office of Science Director, William Brinkman spoke of the program as a "tremendously important part of national laboratory activity."

Brinkman summarized the Office of Science's three thrusts as discovery, meeting national needs, and supporting user facilities for research, the latter's success indicated by a projected 25,000 users of those facilities in FY 2010. He expounded on each thrust against the backdrop of his passion for "discovering new science to change the way we view the world and how we live in it." He was emphatic about DOE's role in "training the next generation of scientists and engineers," an initiative strongly supported by the LDRD programs at all national laboratories, including the three under the NNSA umbrella.

Brinkman described a new program of graduate fellowships and an early-career research-support program, both supported by stimulus funding.

Turning to the crises of energy and global climate change, Brinkman described the problems as "very real," and cited specific instances of research at the three NNSA labs that were addressing the crises, including battery technologies, electric grid restructuring, and the nuclear fuel cycle. "I have never seen a question posed to the scientific community that's more important than this question," he emphasized, affirming his hope that the NNSA and DOE labs would work to develop "increased rigor" in their modeling and experimental approaches. He pinpointed a need to increase the density of DOE and NOAA climate monitoring stations to parallel those monitoring nuclear materials proliferation.

Brinkman concluded optimistically, noting that, at 87 cents per watt, solar photovoltaic has surpassed the goal of its being below one dollar per watt by 2020, and he characterized the developmental efforts of companies working in this arena as "a remarkable thing." With solar cells at 40% efficiency, but limited by the high cost of gallium arsenide as a material, Brinkman expressed a hope that LDRD can contribute to improving this outlook.

"The future of mankind depends on how we handle energy use, CO_2, and population growth."

Multiple Solutions to Grave National Security Challenges

Representing Lawrence Livermore National Laboratory (LLNL), Julio Friedman, of the laboratory's carbon management program was steadfast in his assertion that LDRD was a "disciplined" program" in its allocation of resources, benefitting both NNSA and "broader national needs." Like William Brinkman, Friedman specifically focused his presentation on climate and energy issues, but in the narrower context of LLNL initiatives in these areas, which he binned into the two topics of "climate analysis," and a "basket-full of solutions," particular for "getting CO_2 out of the atmosphere."

In the spirit of illustrating how tools developed for original NNSA initiatives have been fruitfully applied in other arenas, Friedman pointed out how computational tools developed to model nuclear winter scenarios have now evolved into fruitful climate-modeling algorithms. Emphasizing the ongoing effort as a "massive computational scale-up," he pointed out that quantifying nuclear weapons uncertainty now becomes a quantification of the uncertainty in CO_2 emissions verification. For example, LLNL studies have verified that the haze in Yosemite Valley derives from biological processes rather than from human-initiated emissions. Additionally, Fried-

Julio Friedman, LLNL

man described LLNL initiatives in coupling hydrologic models with global climate models, emphasizing water supply as part of critical national infrastructure.

"We're going to have to get this under control," he urged. Livermore is also engaged in wind-flow modeling, designed to decrease wear-and-tear on windmills, thereby increasing their lifetime by as much as a factor of four.

Friedman's final topic was underground coal gassification, which he characterized as doable for half the cost of surface gassification, an initiative thus tying carbon management together with energy conservation, a promising option into which LLNL is considering a large LDRD investment, and in which LDRD-developed tools such as carbon nanotube membranes have already had an impact on lower-cost, more-efficient CO_2 capture. "Many areas in which we've improved US competitiveness have come out of LDRD investments" was Friedman's closing message.

"Many areas in which we've improved US competitiveness have come out of LDRD investments."

The Legacy of Bell Labs

Steve Rottler, SNL

Steve Rottler, Sandia National Laboratories' (SNL) Chief Technology Officer and Vice-president for Science Technology and Engineering Strategic Management Unit delivered a unique perspective on SNL's LDRD program, from his prior role as Chief Engineer for Nuclear Weapons. "Loss of this program [LDRD] would have been devastating [to the life extension program]," Rottler maintained, praising LDRD investments for their role in R&D that delivered ingenious solutions for the post-nuclear-test stewardship of the stockpile. Echoing the theme of Julio Friedman, Rottler elaborated the expansive breadth and depth of SNL's LDRD program on both "growing science and engineering and impacting national security."

As did Jamileh Soudah for the three NNSA Labs, Rottler hearkened back to Sandia's origins as Z Division of Los Alamos, but perhaps even more pertinently, he emphasized that with AT&T's management of the Laboratories came a close relationship and a number of staff from Bell Labs. "Sandia has very deep roots in . . . Bell Labs" in Rottler's view. The point was that the current laboratories do not resemble the single-factor nuclear-weapons-component-engineering organization of the late 1940s and 1950s, but are rather true national security laboratories, "full-spectrum, serving multiple customers throughout the government."

Rottler emphasized two particular areas of LDRD project focus in cyber security, including informatics, systems analysis and other areas, and energy security, including battery innovations, alternative energy storage devices, renewables, and nuclear energy. He cited President Obama's statement emphasizing that "protecting this [digital] infrastructure will be a national security priority," and offered his view of the magnitude and complexity of the challenge. He reviewed SNL's work in analysis of massive data sets and in quantum computing.

In the energy security arena, Rottler reminded listeners that the issue of dependence on foreign oil and exporting U.S. wealth were national security threats. He highlighted SNL's efforts in smaller, more-efficient, shape-conforming, and harsh-environment-resistant battery technologies. In addition, he reviewed a biofuels project, moving toward a single-reactor solution to biomass degradation/conversion to ethanol / butanol and the "Sunshine-to-Petrol" initiative, utilizing solar-thermal technology.

"It was a great thing our country did . . . to establish LDRD."

Shift Happens

William Bryan of DOE's Office of Electricity and Energy Reliability made it clear from the outset that he was neither engineer nor scientist, and his presentation aptly reflected that opening statement. He characterized himself as a customer "on the policy side," and before proceeding, displayed a set-up video using facts and figures to illustrate rates of change and comparative statistics among the US, China, and India. The video clearly hammered-home its final message that "shift happens," and that it occurs and is occurring on a global scale with every tick of the clock.

The issue, of course, is how to plan and execute responses to change that is happening with such rapidity. Bryan pinpointed his role in identifying mitigating strategies, both pre- and post-event in areas of infrastructure reliability, survivability, and resiliency. He emphasized that he focused at a systems level,

partnering with industry to identify causes of energy-delivery interruptions and strategies to make them both more rare and more-tolerable, while supporting FEMA responses in the process.

"We need the eighty-percent solution, now."

Bryan reviewed the history of federal-business partnerships and government coordinating councils, originally set up to mitigate incidents of terrorism. With no major domestic terrorism incidents, since 9/11, but approximately 30 natural disasters, the energy sector has focused more on reliability and resiliency — how to protect and quickly restore energy delivery, within the framework of an all-hazards approach.

Bryan expressed regrets that industry partnerships were, recently, not as strong as they once were, and he, logically referred to several national laboratory initiatives in modeling, particularly referencing an ultimate ability to visualize the electricity-transmission grid in real time. This, of course, also presupposed the topics of battery storage, and the topic of cyber security, a necessity to protect such a computational resource from cyber-attack. "As the grid expands and gets smarter, there is also more vulnerability; are we really taking security into account?" Bryan posed. After the message of his video, Bryan's sense of urgency was palpable. "We need the eighty-percent solution,

William Bryan, DOE/OE

now," he opined, particularly with reference to decisions about where to refine crude oil and to site power lines in ongoing restoration efforts. He described President Obama as directly engaged and related his observation of "quite a dialog between [Energy] Secretary Chu and the president."

Bryan ended by expressing his admiration for the national laboratories in their role of getting new technologies into play. "I love all you labs very much," he exuded, in the context of facing the challenge to leverage the best of national laboratory — and LDRD — research.

Bridging Discovery to Deployment

"How does science and technology respond to problems of this scale?" posed Los Alamos National Laboratory's (LANL's) Duncan McBranch in attempting to outline the scope of the problem of infrastructure security, particularly with respect to future predictions of research directions that will provide the greatest return-on-investment. In the process, McBranch underlined, we will likely be training young people, today, for jobs we don't know yet exist.

In McBranch's view, the national laboratories can and do serve as bridges from discovery to deployment in the "innovation pipeline," and "the LDRD Program is essential in order for us to invest in S&T that feeds the beginning of the innovation pipeline." He emphasized that LANL's program is structured to focus on transformative, not incremental S&T.

"Training young people, today, for jobs we don't know yet exist."

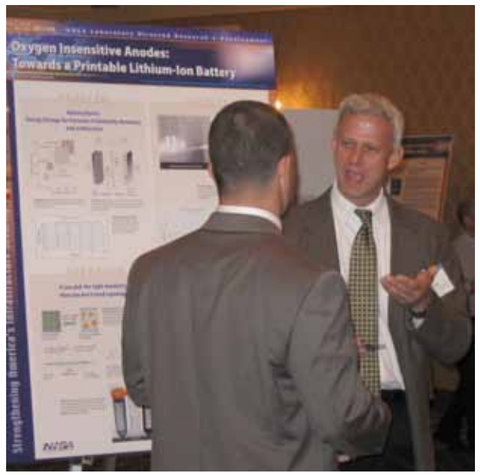
McBranch overviewed several LANL projects in infrastructure security, with emphasis on the idea that these projects engendered transformative outcomes that could not have been predicted at the outset.

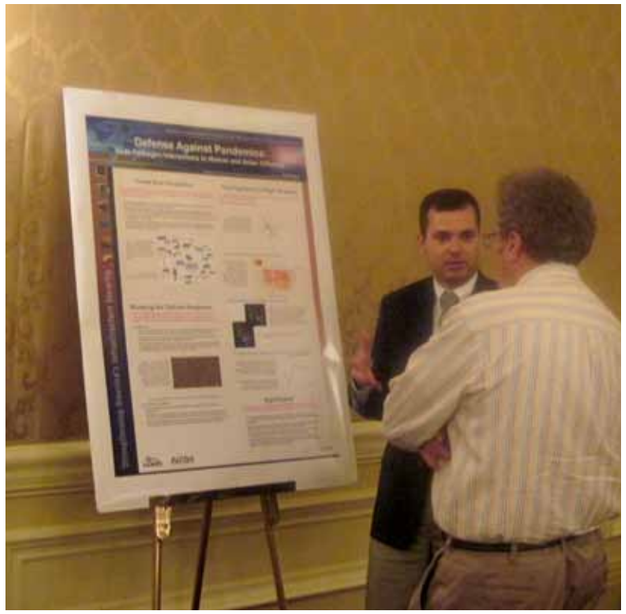
Duncan McBranch, LANL

Reminding his audience that "border security is more than just fences," McBranch exemplified his "not predictable in advance" statement with LANL's Mag Viz, an airport screening technology in early implementation, whose genesis hearkened back to a fundamental research endeavor to combine magnetoencephalography (MEG) and magnetic resonance imaging (MRI) by investigating an ultralow-power version of MRI compatible with the ultrasensitive MEG. Another example was the RAPTOR telescope global network array for space situational awareness, which has "changed the way the astrophysics community looks at events" in space.

McBranch finally discussed LANL's efforts in electricity grid restructuring, such that a truly smart grid would — through sensors, feedback loops and intelligent wind turbines — anticipate impacts, thereby exhibiting resiliency.


Differential Mobility Spectrometry-Mass Spectrometry


Oxygen Insensitive Anodes:
Towards a Printable Lithium-Ion Battery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Using the NNSA Laboratories as a Benchmark

"I'm the DoD lab guy," announced John Fischer, before making it clear to his audience that his job as director of Defense Research and Engineering was, in some sense, one of revitalizing DoD laboratories partly by connecting with, and drawing-out the best aspects of DOE's NNSA labs, using their successes as benchmarks.

"I envy your infrastructure, the scope of work that you do. You are the best . . . no doubt about that," he lauded. And "how do I tap into you, so I don't reduplicate . . . if you already have it." Fisher's obvious admiration for the three NNSA laboratories was tempered by his concern about the changing face of the defense landscape, where the United States "no longer has a single enemy," and where DoD may recognize, as in the case of the F-22, what it does not need, but, where the recognition of what *is* needed may not be quite as easy to anticipate. Fischer reported that Defense Secretary Gates was focusing on small, highly mobile systems that could address terrorist threats and fight "the next adversary." He spoke of the unfortunately "complete surprise" that impacted the military with the extent of the IED problem it was forced to cope with in Iraq and Afghanistan, and he projected the need for "an innovation beyond requirements."

To address these gaps, Fischer is in the process of visiting NNSA labs to find ways of interfacing, expanding DoD capabilities, and "minimizing duplication." He was especially interested in prototyping capabilities that would provide an agile means of responding to continually changing threats. Speaking to the DoD-

John Fischer, DoD

DOE research laboratory relationship, Fischer summarized, "some competition is good, too much is bad," the challenge to leverage the best of national laboratory — and LDRD — research.

"How do I tap into you, so I don't reduplicate . . . if you already have it."

Not the Test Site of Yesterday

Ping Lee, NTS

Representing the Site Directed Research and Development Program (SDRD), Ping Lee delivered a brief but broad overview of the modern-day Nevada Test Site, underpinning his presentation with the long history of cooperative research activity with all three of the NNSA labs. In the past, much of this activity centered around subcritical experiments, or "pushing plutonium around," as Lee lightheartedly characterized it, a crucial activity for stockpile stewardship in the modern era, after the suspension of underground testing.

However, Lee emphasized, NTS's and SDRD's mission is currently far broader, reaching out to other sites run by National Security Technologies, LLC (NSTec), and other programs for defense and homeland security, and depending on its relatively young SDRD program (initiated in 2002), to recruit and retain scientists and engineers with critical skills, enhance core mission-related competencies, and develop innovative ideas and technologies, much like its LDRD counterpart in the three NNSA national laboratories.

In addition to nuclear forensics, logically a descendant of the nonproliferation activity of NTS's plutonium operations, the SDRD program has prioritized research areas such as sensor networks, and IED detection and defeat, and is trying out interesting work in nanoparticle engineering for improved scintillators. Border security through the use of novel, portable active-interrogation technologies, including high-sensitivity chemical detection for counterterrorism is, likewise, an ongoing important area of SDRD research.

"We must transform ourselves . . . anticipating needs to advance solutions for national security."

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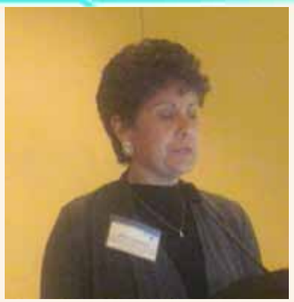
Building Upon the Basic Science Capabilities of the Laboratories



Anna Trujillo, NNSA

Led by NNSA's Anna Trujillo, the Plant Directed Research and Development (PDRD) Program was represented by a panel composed of Bill Faubion, Lee Hamilton, James Mahoney, Pamela Moor, and Davy Shull. Topics discussed included the role of the plants in stewardship of special nuclear material, in tritium-related R&D, including ^{3}H air-monitoring systems, in sensor electronics and packaging, and in participating in supplying nuclear material to reactors, and, of course, in sustaining the nation's nuclear deterrent, and protecting against the WMD threat.

LDRD Panel chaired by NNSA's David Crandall, at lower right.

The Life Blood of What We Do

Chaired by NNSA's David Crandall, the Symposium's final discussion group included Jan Cerveny (NNSA), Barbara McQuiston (DARPA), Walter Polansky (DOE), Tammy Taylor (OSTP), and Brandon Wales (DHS). Crandall's opening message was somber in tone, referencing the effects of scientific and technological progress in changing our culture. "It is no longer appropriate to think of us as enablers of life," he posed. "What we do is its life-blood." Crandall emphasized as did others before him, the daunting nature of the issues surrounding energy and climate change. He characterized LDRD as an "extremely precious resource'" and promised to "defend it, passionately," and to continue to insist that the scientists themselves, not federal administrators, should decide on the important research agendas. "LDRD has shaped the character of our labs more than any other single positive force," Crandall concluded.

Representing the Executive Branch, Tammy Taylor lauded LDRD's role as a test-driver for basic science and ideas, but she also urged DOE to be aware of policy initiatives coming both from the executive branch and from Congress.

Brandon Wales focused on modeling efforts coming to DHS in partnership with the Laboratories' LDRD programs, and he opined that "without the past ten years of modeling, we'd be in a much worse position." He felt that these modeling initiatives were crucial in "getting ahead of the curve," and he told the audience

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Walter Polansky, DOE

that at DHS, the agency "saw how valuable it is, every day."

From his perspective in the Office of Advanced Scientific Computing Research, Walter Polansky focused on cyber security in the context of impending exascale computation, and he suggested changing the "L" in LDRD from "Laboratory" to "Leading."

Barbara McQuiston commented on the logical parallels between the DOE/NNSA LDRD Procsgram and DARPA's role in DoD, both programs "investing in ideas that can make a difference." Focusing on DoD's need for tapping "indigenous energy sources" for warfighters on foreign soil, she emphasized that DARPA was interested in ideas coming from any source and was inviting more collaboration. She "looked forward to continuing the conversation" with NNSA Laboratories and their LDRD programs.

Jan Cerveny of NNSA's nonproliferation/treaty verification/nuclear fuel and security agency (NA-22) talked about the "huge serendipity factor involved in the kind of leading-edge research coming out of the LDRD/SDRD/PDRD programs, characterizing them as "encouraging shifts that we need for extreme advancements into the future." She closed by expressing what appeared to be a quite common sentiment among panel members: "those of you in the laboratories — you're our national treasure."

The panel's final task was to adjudicate the Symposium's best poster, the award going to Chris Apblett of Sandia.

Brandon Wales, DHS

Chris Apblett, SNL, with NNSA's David Crandall

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