16 Integrating Science and Security

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What are the challenges in performing science in a secure environment? Concomitantly, what are the challenges in ensuring security in an institution that depends on performing science at a high level, given that scientists thrive in an open collaborative environment? What positive steps can we take to invigorate the relationship between science and security? In addressing this subject, I will draw on my background serving the Department of Energy (DOE) laboratories in various capacities, and my service on the present DOE Commission on Science and Security.

In an August 1999 editorial in *The Washington Post*, former presidential science adviser Allan Bromley wrote, "No science, no surplus," and one could say as well, "No science, no security." There was a day in the middle of the Cold War when one could ensure security by building taller walls, but today that is no guarantee of security. Cyber insecurity presents us with new challenges. Walls need now to be smartly constructed, intelligent, self-assembling, self-repairing, and transparent, but selectively so.

Today being smart in a secure world requires a sophistication that would have been undreamed of a few decades ago. Not the sophistication of a James Bond world with special cars and tiny, deadly gadgets, and not the new millennium specter of "porta-polys" that are popping up in our DOE laboratory fields. Security now requires an approach that employs science strategically toward solving fundamental problems. Being secure means being ahead in every sense. And science is the key to staying ahead.

Today security depends on a work force skilled on many levels. This theme pervades this chapter. We need a work force that is administra-

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tively sophisticated, technically competent, knowledgeable across disciplines, and politically astute.

Good security is rooted in good science, which is ensured by a skilled scientific work force. Our DOE weapons laboratories are essential purveyors of national security. While my remarks are mainly about these laboratories, they are also appropriate for many of the defense labs. These laboratories are a national resource in which both good science and good security are required.

What are the tensions inherent in bringing good science and good security together? To explore this we need to start with the missions of the labs. We need to look at how science and security can mutually reinforce each other in performing their missions well. We need to look, in particular, at how a scientifically skilled work force can enhance these missions. Can we sustain a skilled scientific work force in light of current pressures on the labs, including security concerns? Is not a deficiency in scientific skills a threat to national security? What are the ways of increasing the pipeline of bright young people who will become staff scientists at our labs?

There are a host of related questions that involve the public's view of the laboratories: What does the public know about the activities underway in our national laboratories? What are some of the ways to counter either the negative or non-impression that the public has of many of our labs? How does this view affect the support of the laboratories' missions and the pipeline?

Another set of important questions revolves around partnerships: Why is the government-university partnership important to science and security? What are some measures that could strengthen this partnership?

I want to address these questions, but I cannot give definitive answers. These questions form the basis of a number of national reviews, including one that I am participating in and will describe below.

Mission

I want to start with the mission of the laboratories, which Robert Galvin's 1995 Task Force on Alternative Futures for the Department of Energy National Laboratories described as the "Energy Agenda." That is, the mission of these labs is to provide superb leadership for the management and development of sources of energy in a way that enhances our national security, helps ensure international security and safety, and researches new multidisciplinary approaches and strategies to supply efficient, cheap sources of energy that will sustain the planet. In more specific language, the mission includes: stockpile stewardship; nonproliferation; intelligence work; countering global terrorism and new threats like biochemical weapons and cyber warfare; alternative energy sources; the environmental impacts of energy use; industrial ecology; energy conservation; and environmental protection. Basic science that probes energy and matter at all scales from the subatomic to the forces that shape the universe is also a mission of the DOE labs. In short, the mission of the labs is to undertake long-term research development relevant to the energy agenda.

Challenges

What are the science challenges? The challenges posed by security threats to the mission require the most modern science and technology. These challenges require expertise in information technology, nanoscience, and biotechnology. For example, stockpile stewardship depends on modeling and simulation. Securing intelligence on an international scale depends on building smart cyber systems. Staying at the forefront of advanced defense systems depends on a nanosystems approach to the manipulation of materials atom by atom. This will be convolved in the future with a biomimetic approach, which learns from nature how to build materials with special properties.

I will give just one example from my own campus, the University of California at Santa Barbara (UCSB), which has a highly interdisciplinary environment. Ten percent of our faculty has multiple appointments not only in joint departments but also in joint colleges, and that is averaged over the entire social sciences and humanities faculty. Some academic departments, like our materials department, have 100 percent shared appointments.

One present focus at UCSB that employs physicists, chemists, biologists, and engineers is silicon biotechnology, or harnessing biological silica production to construct new materials. This approach uses invertebrates like abalones, which produce incredibly detailed silica structures with a nanoscale precision exceeding human engineering ability. This research is starting to reveal the proteins, genes, and molecular mechanisms that control the synthesis of marine organisms. We are finding out more about a very special protein called lustrin, which acts like a mortar between the finely structured shells of the abalone. It has the elasticity of rubber, can absorb a lot of stress, is exceptionally hard to shatter, and has "armor" with a self-healing property. When the protein bonds are broken under stress, they can reassemble. This is the frontier "beyond kevlar." Silicon biotechnology offers the prospect of developing environmentally benign routes to synthesize new materials with stronger adhesive and self-healing properties. Adapting biomimetic principles has led our faculty to make integrated opto-electronic devices in which the routing of light is directed by nanoscale lasers on a silicon chip.

Good security requires that we be a nation at the forefront of technology and this depends on the basic research I have described. Having scientists proximate to the security effort means that the strategy of staying at the forefront can be a shared strategic goal that does not belong just to scientists but also to security specialists, as well as the administrators and staff who oversee the functions that underpin security.

In a white paper to the Galvin Task Force, the Department of Energy wrote, "It's no understatement to say that science and technology are the most important means through which a majority of the department's activities are conducted." The white paper has many examples of how basic research at the labs not only leads to new technologies but also advances entire fields of research, like high-energy and nuclear physics, plasma physics, nuclear medicine, nuclear engineering, supercomputing, global climate research, and systems ecology.

In addition, DOE said the following on the subject of national security, specifically the stockpile stewardship program: "Science and not nuclear testing will be the foundation for maintaining confidence in the safety and reliability of our nuclear deterrent." And, "A strong foundation of science and engineering should underpin all of DOE's programmatic missions."

To look at the issues of science and security compatibility, DOE recently commissioned a group of scientists, policy experts, and former laboratory administrators in the federal agencies. Its charter is to "assess the new challenges facing the Department of Energy in operating premier scientific institutions in the 21st century in a manner that fosters scientific inquiry and exchange while protecting and enhancing national security." The Commission on Science and Security informally goes by the name of its chairman, John Hamre.

This is what General John Gordon, USAF, head of DOE's National Nuclear Security Agency (NNSA), said in April 2001, to the Special Oversight Panel on Department of Energy Reorganization: "We have a commission of a group of eminent Americans known as the Hamre Commission to review the entire issue of science and security. To help us make sure we get the right picture and perspective. I have warned them to be very careful with their recommendations—many are likely to be implemented. I have called for a six-month moratorium on implementing any *new* safeguards and security policy. We are using this time to review past policies, identify policy improvements, and determine how policy can most effectively be implemented within the NNSA."

As a member of the Commission, I can tell you that we have reviewed recent relevant reports, and a lot of good reports have been written over the last decade. We have reviewed reports of the Galvin Task Force, the Chiles Commission, the Rudman Commission, the Baker-Hamilton Committee, and the National Academy of Sciences, and we have consulted with many experts in government and independent institutes. We are traveling to almost all the DOE laboratories, including the tier-one, tier-two, and tier-three labs. We will finish these visits shortly. During these visits we have met with various focus groups. These include new young employees; the more senior employees who have been at the labs for awhile; administrators; and researchers, both those who do predominantly classified work and those who do no classified work.

At this stage of the Commission's work (since it is a work in progress), it is appropriate to mention only some of the questions that we are looking at. One question is: How do security regulations and procedures impact scientific productivity and the science addressed at the labs? We have certainly heard a lot about that from the lab employees. Their overall feeling is that increased regulations and administrative burden from compliance is diminishing their productivity significantly. This dampens the work force's morale and has affected recruitment and retention.

How does the changing face of science, the new focus on, for example, nano-bio-information technologies, impact the security challenges? Are the lab scientists in a position to integrate these new scientific advances into national security activities? The feeling of laboratory staff is that the openness and external collaborations that are required to be at the forefront science today may be thwarted by a zealous, over-extending security culture that is based on compliance rather than risk.

What is the nature of the federal investment at the labs? Is it done with a strategic approach that integrates science and security or is it done by funding science and security in separate funding pots? Does the investment approach enhance security or does it hamper it? Those are some of the issues that the Hamre Commission is looking at.

Recruitment, Training, and Retention of a Skilled Work Force at the Laboratories

Last fall, the Secretaries of Defense and Energy submitted to Congress a report titled "Nuclear Skills Retention Measurements within the Department of Defense and the Department of Energy." The Secretaries described a diminishing work force. The average age of critically skilled employees at Office of Defense Programs labs is 47 years. (Scientists, engineers, and technicians make up 75 percent of these critically skilled employees.) The average time to retirement for these employees is 14 years. Only three percent of critically skilled employees are less than 30 years old. More than one-third are more than 50 years old. And 61 percent could retire in the next nine years.

Their survey showed that too few employees are entering this critically skilled work force at young ages and many of the best scientists are being recruited away, not just by industry but by other universities who value their skills. Our Commission also saw evidence of this in its visits to the labs.

This situation is corroborated by lab recruiters who tell us that for the past couple of years nobody has turned up at their job booths at university job fairs. There are many possible reasons of course. Among them are the students' perceptions of increased security requirements at the labs, a less attractive work environment, negative public opinion about the labs, tales of restricted travel for lab employees, noncompetitive salaries, and the uncertain stability of laboratory budgets.

The 1999 Commission on Maintaining United States Nuclear Weapons Expertise, chaired by Admiral H.G. Chiles, Jr. USN (Ret.), recognized that many approaches are needed to counter this situation. It had a very interesting idea. It spoke in favor of providing cutting-edge facilities in a challenging programmatic environment to promote recruitment and retention because it deduced that what stimulates young people at universities are intellectual challenges. These kinds of facilities invite collaborations with universities and industries worldwide and are very important in attracting students after graduation to the labs. The most effective recruitment can be in steps: first, as a student visitor, then as a postdoc, and finally as a staff member. (It is interesting to note that at the Los Alamos National Laboratory, about one-third of its scientists and engineers in critical-skill positions were originally postdocs.)

The Chiles Commission spoke of the need for a coherent, executable, and well-managed program with stable funding and a strong sense of purpose. It emphasized the importance of reinforcing this program with statements of national commitment from Congress and the White House. The Commission also discussed the need to adopt security practices that do not unduly restrict scientific interchange or degrade the work environment. It noted that graduate fellowship programs and summer institutes at some of the laboratories encourage a flow of students that learn about the work of the laboratories. These programs serve as important recruitment tools.

Balancing Security and Openness

One of the hallmarks of good science is openness. How does openness benefit a security environment? How can you have scientists and engineers who worked in open environments at their universities then go to the laboratories?

The National Research Council (NRC) examined this question in its 1999 report titled “Balancing Scientific Openness and National Security Controls at the Nation’s Nuclear Weapons Laboratories.” The Commission, chaired by Richard Meserve and John McTague, discussed the importance of open, cooperative research in an international sphere.

A good example, the Commission said, was the cooperative program with the Russians to upgrade the protection, control, and accounting of weapons-grade nuclear material in Russia. Its report noted that a spirit of reciprocity, transparency, and cooperation is necessary to implement and verify nuclear arms reduction. It also noted that openness is important in attracting and retaining scientific talent. And it observed that openness can serve to facilitate good policy formation in national security, pointing to the example of the management of plutonium for military and civilian purposes.

The NRC Committee emphasized that the key to a balance between security and openness is recognizing what is important to secure and what is of limited or marginal significance. In other words, “build high fences around narrow areas.” The Committee encouraged tailoring the level of security to the magnitude of the risk, educating and training staff in security procedures, and keeping security procedures focused and streamlined.

The Public's View of the Labs

Surveys and reviews show that, for the most part, the public does not know much about the energy laboratories, and is confused about their missions. The multipurpose labs have a profusion of missions and look alike. The labs that do mainly security work are tainted in the public's eye with the specter of nuclear weapons, and judged by a few well-publicized security lapses. How to overcome this is a challenge that needs to be met by the ensemble of labs working together to 1) articulate the nature and importance of the overarching mission, 2) define clear focuses for each laboratory, and 3) engage congressional support for a national commitment to the missions of the labs.

Conclusion

I have summarized several of the issues surrounding the convolution of science and security. Given that good security needs good science, what can we do to bring science and security into closer harmony? As I mentioned at the beginning of this chapter, a number of thoughtful blue ribbon reports have evaluated the situation at the labs over the past decade, and the Hamre Commission is in progress. The past reports contain a wealth of recommendations and models, and at least some of these should be implemented or expanded upon. These reports point to the need for a laboratory system that represents its vision and mission more coherently to the public. The Galvin Task Force said that, "the laboratories should work more closely as a system, with the goal of achieving enhanced coordination and integration of complementary strengths." In its vision, the individual labs would focus on areas of excellence, and collaboration with other labs in a virtual network that builds broader competence throughout the system.

Past reports point to the need for increased partnerships with universities, and more university centers focused on areas of mutual interest. This would encourage a pipeline of bright, young people. It would also encourage a level of excellence that would retain the best and brightest laboratory staff. And it would make profound contributions to national security by engaging the best minds from all sectors.

For example, the Accelerated Strategic Computing Initiative (ASCI) has, by virtue of having outstanding simulation tools (for the Science Stockpile Stewardship Program), developed excellent collaborations between the labs and the best universities and their students. Are there other large federal initiatives that could encourage university collaboration? This would have the potential for developing the next generation of scientists to fill critical positions at the labs.

The ASCI program has several simulation centers at universities, all of them established through open competition. I was part of the NRC's Fusion Energy Science Committee, which last year recommended that DOE establish other university-based centers that would nourish relationships between university and DOE laboratory scientists. This model, done so successfully by the National Science Foundation through its Science and Technology Centers and Engineering Research Centers, is a good one for leveraging expertise and resources, enhancing excellence in strategic areas, building support from a broader community, and developing careers in science and technology.

The fundamental question posed in my chapter, namely, how to ensure good science and good security, could not be more timely or important, given the rapid advances in technology, the rising tensions between nations, and a laboratory workforce challenged by recruitment, retention, and morale problems. Accomplishing the effective integration of science and security at our national laboratories will depend on how we bridge two disparate cultures, the culture of science and the culture of security. One demands openness, worldwide collaboration, and infusion of diverse, global talent to prosper; the other requires secrecy and other safeguards to protect what needs protection. Yet these two cultures have to work together to sustain and enhance the missions of the laboratories. A renewed security model that fosters a partnership between these cultures might be built upon the following principles: first, that maintaining the highest standard of security requires being at the forefront of science so that the most recent scientific advances are embraced in the technology that underpins security; second, that an effective security model requires the integration of many elements, including cyber security, intelligence, counterintelligence, and safety; third that laboratory staff need to be involved in constructing a security model so that the model promotes and enhances the laboratory missions; and fourth, any security model must be risk-based and must have the capability of responding to changing threats. The later depends on careful and continuous assessment of risk, an activity that should be undertaken by all purveyors of national security, including, but not limited to the DOE.