

## Federal Laboratories: Understanding the 10,000 – *Barry Bozeman*

Federal labs came under siege when the Republicans won a majority of seats in the House of Representatives in November, 1994, and Newt Gingrich became Speaker. Already reeling from an outbreak of peace, the last thing the federal laboratories needed was political leadership devoted to the arcane 19<sup>th</sup> Century, nihilist political principle, “Let's blow it up and start all over again.” As it turns out, very few labs have been blown up, the only significant one being, appropriately enough, the Bureau of Mines Explosives Testing Lab in suburban Pittsburgh.

However, federal laboratory personnel cannot feel too much at ease as long as influential members of Congress have the Departments of Energy and Commerce in their gun sights. Federal labs have been victims of social and political forces over which they have no control. They have also, in many instances, been their own worst enemy. Federal laboratories have been accused by the General Accounting Office of waste due to poor accounting practices. The Department of Energy's Inspector General's Office accused the Department's federal labs of mismanaging cleanup of contaminated land. A whistle-blower who called attention to the vulnerability of a nuclear plant was demoted. Perhaps strangest of all, a ghost from the 1950s came back to haunt us as we found out about insidious nuclear experiments being performed on non-volunteers.

My personal favorite came from *The Consumer's Digest*. Amongst all the product reviews of leaf blowers and new cars, there was an article about the war on Washington waste. In it, *Consumer's Digest* complained erroneously that the Energy Department spends one-fifth of its budget on cooperative energy development programs, giving money to firms like General Electric and Westinghouse to support research so they can turn a profit.

I do not want to blow up federal laboratories. That may be an extreme position these days, but to me, it makes about as much sense as blowing up land grant universities because we no longer have a predominantly agricultural economy.

In my view, the fate of the U.S. federal laboratories is a matter of great consequence. Whether or not you agree with a former laboratory director that federal laboratories are “a reservoir of scientific and technological talent that can help to compete in international markets,” whether or not you are impressed with the Nobel laureates working in federal labs, the resources devoted to federal laboratories have to command attention.

More than \$20 billion per year is spent on R&D for the 627 federal R&D laboratories, which amounts to about one-third of all federal R&D funds expended. Federal laboratories employ nearly 60,000 scientists and engineers, a significant fraction of the U.S. scientific and technical resource base. In addition to producing tens of thousands of scientific and technical papers each year, federal laboratory personnel file nearly 1,000 patent applications. The range of functions performed by federal laboratories is remarkable.

The core functions of such mega-labs as Sandia or the Naval Research Lab are familiar. These labs are involved in a wide range of activities, many of which stretch well beyond the core concept of their missions. If the largest labs receive the lion’s share of attention, 700 or so less visible federal labs undertake an even more diverse array of scientific and technical tasks, ranging from collecting and analyzing seed samples at the U.S. Department of Agriculture’s National Seed Storage Laboratory in Fort Collins, to devising building materials that will resist terrorist attacks at the Army Construction Engineering Research Laboratory in Bloomington, Illinois. Federal laboratories are engaged in research at every point on the spectrum: basic, pre-commercial, direct, applied, development, and testing.

My objective is to assess and add to the list of ideas about policy change in the federal laboratory system. Before doing so, I am going to outline some of the characteristic flaws in policy frameworks that have been used to analyze R&D policy in the United States. My perspective on this has been developed during my work under the aegis of the National Comparative Research and Development Project (NCRDP), which was begun in 1984 and involved researchers in four nations on a wide variety of technical reports and papers.

During nearly 13 years of work in the NCRDP, we interviewed or sent questionnaires to more than 1,000 scientists, science administrators, and science policy makers in Japan, the

United States, Canada, Russia, Korea, Germany, and England. We visited R&D laboratories of every sector and stripe: industry, government, university. Many of these include the largest R&D laboratories, including Lucky Goldstar in Korea, the National Institute for Metals in Japan, and the Brookhaven National Lab. We also spent a good deal of time in the hinterlands, the Fort Keough livestock research center and the Chalk River Atomic Laboratory.

There have been three predominant science and technology policy paradigms in the United States since the beginning of our science policy. The market paradigm for science and technology policy and its attendant economic development implications is based on familiar premises, that free markets are the most efficient allocators of goods and services, and that left to its own devices, an unfettered market will lead to optimal technology and economic growth outcomes. Most policy in the United States, not just laboratory policy or science and technology policy, is strongly influenced by the market paradigm. This paradigm is alive and well.

The mission paradigm has been particularly prominent. The earliest government involvement in science and technology policy was within its framework. The mission paradigm assumes that the federal laboratories' role in science and technology should flow directly from legitimated missions of agencies and should not extend beyond those missions in pursuit of more generalized goals such as technology development, innovation, or competitiveness goals. As such, the mission paradigm is not radically different from the market paradigm. Its roots can be traced to early government involvement in national defense, public health, and, to some extent, agriculture. The mission paradigm is alive and well – witness the Department of Energy's "Alternative Futures for the Department of Energy National Laboratories" (Galvin Panel 1995).

More recent is what I call the cooperative technology paradigm. During the economic downturn of the late 1980s and a perceived crisis in U.S. competitiveness, many of our core assumptions began to be examined, including the bedrock faith in the private sector as a source of all innovation. This was particularly the case as other nations, especially Japan, began to take a different tack and have some success in technology development.

During the 1980s, a number of policy initiatives challenged the preeminence of the market paradigm with a new model, the cooperative technology paradigm. As I use the term, the cooperative technology paradigm is an umbrella term for a set of values that emphasizes cooperation among the sectors: university, government, industry, and cooperation among rival firms in development of pre-competitive technology. Today, the cooperative technology paradigm is alive, but on support systems. It's not doing so well.

The time has come for a new paradigm, one I call the institutional design paradigm. It is oriented toward resolving three major problems that permeate policy making in the United States pertaining to federal laboratories.

First, and probably most important, is a poor basis of empirical knowledge about laboratories in the United States. Not many people even know there are over 16,000 of them. We are concerned about licenses that come out of the federal laboratories, but don't know how many came out last year. In the interest of managing laboratories, we might want to know the administrative intensity level, or the ratio of administrators to scientists. What is the average level? What would be a good level? Nobody knows the answer to questions like that. While we know a great deal about specific labs, we have a very poor empirical base of the system as a whole. We know a great deal about specific sectors, but very little about the system as a whole and its mechanics. That is problem number one.

A second problem is what I call the hazards of stereotyping. It is no longer possible to try to define a "government lab," versus a "university lab," versus an "industry lab." The truth of the matter is, there is as much variance within sectors as there is across sectors. Increasingly, assumptions such as universities are for basic research or industry is for development and commercialization of technology run at odds with the configuration of research resources that we have in the United States.

The third problem is too much ideology and not enough pragmatism. In many instances, the reasons that discussions of science and technology policy in federal laboratories seem to push people into ideological corners is that ideology becomes a sort of a shorthand for a lack

of empirical knowledge. It helps us keep a handle on assumptions that we want to make in policy making, in the absence of any empirical knowledge about the outcomes and effects of particular policies. The institutional design approach was developed to try to alleviate some of those problems that are characteristic of policy making for science and technology.

The institutional design approach for science and technology policy is based on just a few straightforward principles. The *player principle* says that most R&D organizations in the United States should be ignored. Most R&D organizations in the United States, more than 10,000, are basically small engineering job shops run out of firms. They may be very helpful to the firms, but they are not particularly innovative and do not contribute to national innovation.

On the one hand, we can ask, “With 16,000 R&D laboratories, how are we ever going to understand enough to make empirically-based decisions about them?” The answer is, “We don't focus on all of them.” Because, in fact, there are only about 500 or so that really have the potential to contribute to the national innovation system. This is particularly so if we exclude the handful of small firms that are producing most of the innovations.

The second principle, the *systemic principle*, is that we need to know something about the dynamics by which laboratories inter-relate and respond to environmental change. If we want to understand the impacts that public policies will have on laboratories and not just science and technology policies, but tax policies or labor policies, we have to understand more about the system as a whole.

The *never in neutral* principle says that when we implement public policies in laboratories, those policies are never going to be neutral with respect to existing functions. For example, if we provide a manufacturing extension function to federal laboratories, it affects the preexisting mission of the lab. The work we have done trying to assess the impact of industrial partnerships with federal laboratories has certainly made that clear.

The *comparative advantage principle* says that public policy should be differentiated, targeted, and based on a lab's capabilities and proven areas of effectiveness, not its particular affiliation

with respect to agency or sector. Laboratories, quite simply, should be reinforced for doing what they do well. If we want to talk about downsizing or closing laboratories, the reason to close them is because they are not doing well what they are supposed to be doing well.

The *opportunity cost principle* has more to do with the way we should evaluate federal laboratories. It is actually a pretty complicated notion about evaluation, which is that it is not enough for a laboratory to show a positive marginal cost benefit ratio. It is not enough to be able to say that this money was expended in a certain way with a certain multiplier effect. The real question is, “What would have happened if the money had been expended in some other way, particularly ways in which money is already being expended by the laboratory?”

The problem with the institutional design approach is that there are a number of prerequisites, most of which are not now in place. One of the most important prerequisites is a greater knowledge of laboratory assets, capabilities, and performances. Most efforts to measure the assets of laboratories have met with little success. In our own efforts, we have focused on certain areas, but there are wide gaps in the kind of knowledge that we have been able to develop.

Another prerequisite is greater coordination and coordinating apparatus. If we are going to implement an institutional design approach, greater coordination is absolutely required. That does not necessarily mean coordination by bureaucrats, but a variety of stakeholders should be involved in coordinating federal laboratory change.

An additional prerequisite for institutional design is a reduced role for line agency management. I have seen nothing to convince me that the federal laboratory systems’ agency affiliation is rationalized in terms of mission or management structure. There is relatively little flexibility even now and not enough decentralization in the federal laboratory system to allow the implementation of an institutional design approach. If we are going to get serious about changing federal laboratories, we have to identify likely agents of change and provide the resources and political will to help federal laboratories fulfill their enormous promise.