

## Toward a National R&D Policy – *Peter Eisenberger*

In this article, I begin by reviewing the thoughtful efforts of others to suggest a new framework to replace the Bush paradigm. After that, I outline the parts of a new framework that I believe need to be emphasized.

Before doing that, I would like to identify the factors that have created the need for a new framework. These are not new, but they are the drivers for the efforts of others and the factors which have influenced my suggestions for a new framework. These major drivers are:

- 1) the replacement of defense by civilian and commercial objectives for research and development;
- 2) global competition and growing concern over global constraints on resources;
- 3) the difficulty of wealth generation and the fast pace of innovation;
- 4) the information age and changing organizational and management practices;
- 5) the increased complexity of important scientific problems, emerging technologies and societal problems; and
- 6) the related increasing importance of education generally and the growing gaps in understanding between the science and technology generators, the decision makers, and the public.

In response to these six factors, there have been three reports that attempted to provide input to developing a new framework for R&D. One was the work of the American Association for the Advancement of Science's (AAAS) Committee on Science, Engineering and Public Policy (COSEPUP) in 1993, *Science, Technology, and the Federal Government: National Goals for a New ERA* (COSEPUP 1993). The second one was the National Academy of Science's Committee on the Criteria for Federal Support of Research and Development, chaired by Frank Press, in 1996. And the third was the recently issued report by the Council on Competitiveness, entitled, *Endless Frontier, Limited Resources: US R&D Policy for Competitiveness*.

While each of these reports was written with varying degrees of participation from the university, government, and industrial sectors, one can loosely associate the COSEPUP report with academic concerns, the Press report with government concerns, and the Council on Competitiveness report

with industrial concerns. One of the points I will return to later on is that this historic separation of the three sectors which was built into the Bush paradigm is fragmenting our R&D efforts. This needs to change.

Starting with the COSEPUP report recommendations, the first goal is that the United States should be among the world leaders in all major areas of science. They reasoned that achieving this goal would allow the nation quickly to apply and extend advances in science wherever they occur. The second goal is that the United States should maintain clear leadership in some major areas of science. Finally, the comparative performance of U.S. research in a major field would be assessed by independent panels of experts from within and outside the field.

The Press report had as its main recommendations, first, that Congress should create a process to examine the entire federal science and technology budget before the federal budget is disaggregated into allocations to appropriations committees and subcommittees. Furthermore, the President and Congress should ensure that the federal science and technology budget is sufficient to allow the United States to achieve preeminence in a select number of fields and perform work at the world class level in other major fields. This clearly supports the COSEPUP report's recommendations.

The Press report also recommended that federal science and technology funding should generally favor academic institutions because of their flexibility and inherent quality and because they directly link research to education and training in science and engineering. This recommendation has elicited a firestorm of response. As a complement to this support for academic institutions, the Press report recommended that the federal government should retain the capacity to perform research and development within agencies whose missions require it. They argued that the nation should maintain this flexible and pluralistic system of support.

The main findings of the Council on Competitiveness report are first that R&D partnerships hold the key to meeting the challenge of transition that our nation faces, and second, that the United States has an urgent interest in resolving the current polarized debate over the proper federal role in R&D. The Council included very thoughtful, detailed suggestions for each sector.

Those three reports provided expert input on how to develop a new framework for R&D. Now I will present my perspective on a new framework, unconstrained by current political correctness considerations or vested interest considerations.

I have been thinking about the need for a new framework for over a decade, ever since I had the responsibility to downsize and redirect Exxon's corporate research laboratories in 1986. I began by asking the question, how serious is the need for change? I concluded that the need is great, not only because of the current forces of change, but more importantly, because all three R&D sectors developed some very bad habits during the golden age of Vannevar Bush. Like any human or natural system, a long period without real stress makes the individual components and the overall system less prepared for real challenges. One is, in a sense, most vulnerable at such a transition; yet one has the strengths created during the period of abundance to bring to bear on the new challenges. This is related to the conventional wisdom of, if it ain't broke, don't fix it.

But I believe significant departures are required from past practices in each of the sectors and, most notably, in the system as a whole. The changes should be made carefully to protect the real strengths of the current system, as these will be useful in facing our new challenges. However, an indication of how much change I believe is needed is that I can only come up with three major items that need protection.

First, echoing the recommendations of the three reports, I believe our investment in university education and research infrastructure needs to be preserved and even strengthened. This recommendation does not trace its roots to my own place in academia; I said this even when I was in industry. In making this recommendation, I am not endorsing all university practices in education and research, which need to change; nor am I saying we need as many research universities as we currently have, because we don't.

The second major category I believe needs to be preserved is the national research facilities, like those which provide high magnetic fields, photons, and neutrons. Many of them are housed in our national laboratories. Expensive, state of the art capability will certainly be needed as we address the complex future in both scientific and technology terms. Here again, I don't want to imply that all the facilities are well run or that all the ones we have are needed.

Finally, I certainly want our industries to maintain a vigorous research effort. Here I am less concerned than others about their short term orientation. In a better coordinated research and development system, others can perform the longer term research. In general, I believe industry has already taken major and painful strides to address long term issues. Among the three sectors, it is currently best prepared to address the future.

Now I will turn to my framework for R&D for the 21<sup>st</sup> Century. My focus is on the parts of the framework that will help achieve the goals of excellence and effectiveness. By effectiveness, I mean contributing to developing the knowledge base and technological innovations that are needed in a timely and cost effective manner. First, I recommend a periodic, comprehensive review of federally funded research programs. Each program should be required to prioritize current activities in terms of excellence and strategic importance. A national committee of wise persons, those with experience in science but without current vested interests, should review the assessments and choose where to make the cut in excellence. We have a lot of excellent programs, but one consequence of our golden age is that a lot of low quality, unimportant work is being publicly supported. Many of my colleagues suggest that the number may be as high as 50 percent in their field – not in somebody else's field, in their field.

Most importantly, we must initiate this process ourselves rather than having a more political process imposed on us from the top in reaction to budget reductions. Industry made a mistake in this regard. They put themselves in a reactive position rather than preparing themselves. As a result, their research efforts suffered much more than they had to.

Next, I would follow some version of the COSEPUP recommendation to determine a national research portfolio. This should be done by mission, not discipline, and it should both question existing missions as well as add new ones, like exploring the frontiers of science, excellence in education, improving quality of life, and the environment.

The savings achieved by the excellence assessment should provide resources to preserve and strengthen the needed infrastructure and create new programs in areas needing additional effort

based upon our new portfolio analysis. In the parlance of today, this should be a balanced budget exercise.

Even more important and of greater difficulty is the goal to achieve greater effectiveness. This is where the Bush golden age has taken its greatest hold. There are many reasons for this, a notable one being that in some sense, the Bush framework as it finally emerged was an ineffective design. The experience of developing the bomb was more profound on the science community than we admit. The community wanted to avoid national coordination, which at that time meant military control.

There are many other reasons for our current poorly-coordinated innovation system, including self-interest. No one likes to be given direction. Also, the cultural and political consideration is that central planning and/or industrial policy is bad. Here again, I agree with the three reports, which to varying degrees call for a more coordinated approach to a national R&D.

The changing nature of the innovation process and the global nature of economic competition require that we function effectively as a team. Many feel threatened by this, and there are the standard arguments of how planned efforts fail, but doing it right is the challenge we currently face. An uncoordinated approach certainly is a good defense against mistakes, but I don't know any field of endeavor that has serious outcomes and operates under constraints that has an uncoordinated approach as its method of choice. We certainly should build some degeneracy into the system, and use the strength of our current bottom-up approach to avoid any central planning disaster. But we must use our existing investments much more strategically than we are now doing.

The second major area needing change to achieve effectiveness concerns the internal practices of our universities and government laboratories. This will be the most painful. Here, we should follow the lead of industry but avoid making the mistake they made in relation to their employees. Our objective should not be downsizing, but rather, to get more productivity out of our existing assets. In this process we must preserve and even strengthen the environment which nurtures creativity and is supportive of the many excellent researchers in our university and government laboratories. The goal is to get more, not less, out of the best and brightest in these institutions.

This institutional effort to achieve enhanced effectiveness should be comprised of two components. First, there should be a top-to-bottom review of existing practices and procedures, asking each one whether it meets current needs and whether it can be done better in a different way. There have been several tentative attempts in universities to address this issue, but they have been too constrained by the culture to produce the needed changes. The reason for this is related to the second aspect, and the most radical from the perspective of my university colleagues. Put simply, the political center needs to reassert more control over its institutions. The social contract needs to be redrawn, especially in our universities, to reflect greater concern for, and contribution to, the goals of the institution. Not surprisingly, since it involves the same people, the balkanization of our institutions is similar to the fragmentation at the national level that impedes a coordinated effort in support of our country's objectives. Without discussing the intellectual consequences of disciplinary balkanization on our research efforts, I will state that these also need to be addressed in the proposed review.

Clearly, many other areas need to be addressed as well. For example, do we need to promote the formation of new kinds of institutions between our universities and industry to provide improved effectiveness for our national innovation process?

In sum, the design parameters I would recommend for a new research system should include the following features:

- 1) it should promote the assessment of fields and programs in addition to individual efforts;
- 2) it should facilitate the termination of programs which are not performing adequately;
- 3) it should promote the development of a national portfolio which reflects both scientific and strategic priorities and in particular, and should enhance focus on quality of life concerns;
- 4) it should strengthen the ability of institutions to direct resources towards achieving institutional goals; and
- 5) it should promote greater institutional responsibility to initiate reforms in their practices and procedures so that they can more effectively contribute to national goals.