

Show Me the Money: Budgeting in a Complex R&D System –

David Robinson

The problem of budgeting for R&D has been with us a long time. Simply stated, it is this: where is the money going to come from? Today, we still do not know where the money is going to come from. My major thesis is that broad considerations of resource allocation among sciences make little sense. For most activities of government, science and technology are not goals in themselves, but are linked to major societal goals.

There is a long list of major societal goals to which science and technology contribute, including:

- improving quality of life, health, and human development
- increasing knowledge;
- expanding education and the diffusion of knowledge;
- improving personal and public health and safety;
- contributing to a high standard of living;
- creating and maintaining a civic culture;
- fostering community harmony;
- stabilizing population growth;
- nurturing a resilient, sustainable, and competitive economy;
- promoting economic growth, including increased employment and work force training;
- improving international competitiveness;
- modernizing communications and transportation;
- increasing environmental quality and sustainable use of natural resources;
- fostering worldwide sustainable development;
- enhancing resource exploration, extraction, conservation and recycling;
- securing personal, national, and international security; and
- improving social justice, individual freedoms, and worldwide human rights.

Science and technology contribute to all of these societal goals, yet most discussions of fund allocations ignore them and focus only on the economic and competitive aspects. One of

the important national goals we have agreed upon is the advancement of science itself. In this area, we can talk about resource allocation. But if 90 to 95 percent of the federal expenditures on science and technology are discussed in the context of other goals, then it is the priority and balance among those goals that should be the major factor in the choice. In short, budgeting for science and technology is a major part of the political process. Instead of looking at fields of science as competing against each other, we should look at what our national goals are and how we make decisions regarding the allocation of funding for them including their science components.

Expenditures on science and technology are going to uncover new knowledge. They're aimed at improving things in the future, often the very far future. When preparing budgets, mission agencies have to balance funds they need to address today's problems vis a vis funds that will (or may) make their job better in the future.

Today, how much is the nation spending on cancer treatment? How much on prevention and education? How much on cure? If we develop a cure for heart disease and cancer, can we let kids start smoking cigarettes again? Technology fixes are always something we're interested in.

To summarize, my thesis, is that there is not a single science and technology budget. There are science budgets linked to various societal goals (as defined through the political process), and the budgets should be determined by how they fit those goals. The priorities should be attached to the programs, and should bring along the appropriate science and technology budgets with them. It should be left up to the agency or the research lab to make the case that the funds spent on science and technology are worthwhile and are going to make measurable progress towards these goals.

In the 1960's, I saw how this case was made at the National Institutes of Health. James Shannon – the brilliant leader of NIH when I worked in the White House – had a long-term, three-step plan for supporting scientific research. Year after year, he inveigled more money from Congress than the administration had proposed.

Shannon's first step was to promote both non-governmental and Congressional support. Enlist non-scientists like Mary Lasker and private, disease-oriented organizations. Cultivate Congressional committees. Shannon was wonderful with Congressman Tom Foley and Senator Lister Hill.

Second, demonstrate that immediate breakthroughs are possible. Be disease-oriented rather than health-oriented. It is much easier to list the diseases that you hope to cure rather than to explain the connection between current appropriations and the long-term health of the nation.

Third, invent special institutes. Every time you focus on a new disease, set up a new institute. Describe the budget by working from the specific to the general. Shannon would always talk about how much he was spending on heart catheters, for example, and then expand from the arteries of the heart to the heart as a whole, to the body as a whole, to other diseases as a whole. In this way, he could justify his budget.

Shannon also invented a research project category which, as a physical scientist, I had never heard of when I came into the White House. It was called "approved, but not funded." Scientists would apply for grant funding and would have their applications approved. Shannon would then go to the Congress and say, for example, "We approved research grants worth \$500 million. But we only had \$400 million to spend. So we have \$100 million of grants that were approved, but not funded." On hearing that, Congress replied, "We better give you the extra \$100 million to enable you to fund everything that you've approved." The next year, Shannon would come in with an additional \$100 million of projects that were approved but not funded. So it went.

The other strategy Shannon perfected was funding multi-year programs "subject to availability of funds." He would approve a five-year grant, but only fund the first year. Since the federal budget is for one year at a time, the next four years would be "subject to the availability of funds." Shannon would go to Congress the next year and say, "We have \$400 million in grants we've already promised subject to availability of funds." Congress would start from that spot and vote additional money.

The other major point Shannon looked at was expanding the infrastructure. He started development programs and research in undeveloped areas of the country. He started a whole computer program in the 1960's, before anybody thought that computers would be important in biomedical or biological research. He supported proven investigators long-term and junior investigators short-term. He invented "Training Grants." He was allowed to fund research only, but he supported graduate students by calling it "research training." In sum, by having a program that he could justify to the American people over a long period, starting in the 1950's, Shannon built an NIH which spends significantly more than the National Science Foundation (NSF) spends on research.

One could give similar examples in other agencies. The Department of Agriculture started out as a research-oriented agency in the 19th century. The DOA used its support of science and technology through field stations and agents to develop general public support of science and technology.

I started out by saying, look at the institutional goals, look at the science and technology needed to meet those goals, and try to develop programs to justify that science and technology. What's wrong with this picture? Why can't we just look carefully and frugally at all of the government missions and opportunities, put together the required science and technology budgets, and go home?

For a first approximation, that's fine. But in the second approximation, these mission activities often overlap. I was involved in a situation once where three agencies, the Air Force, the Weather Bureau, and the Geological Survey, were all interested in research on hail. All three agencies were sending airplanes to the same part of New Mexico at the same time of the year, because that's where most hail storms seem to be.

We have to coordinate and rationalize between and among the departmental budgets, and we must do more to eliminate unnecessary duplication of research. Cooperative activities should be encouraged. Some programs contribute to more than one goal. For example,

computing for Defense can be valuable to the nation's pursuit of other goals, such as commercial technology and economic growth.

And there is a special situation with regard to fundamental science and technology. The NSF mission is to support basic science and engineering. In allocating its budget, the NSF has to be aware of scientific opportunities in what other agencies and the private sector are doing, then try to exploit the gaps in research.

This balance wheel function is troubling to some. In general, it appears to me that the NSF has to strive for continuity and balance, trying in all areas to respond to the highest quality proposals and to produce the people we need for the country.

The Stever taskforce of the Carnegie Commission on Science, Technology, and Government pointed out that the science and technology base must be built for the future (National Research Council 1992). We have to support: general science and math education; the science literacy of the public; higher education in science, engineering, and the social sciences; human resources; facilities; and institutions. These are long-term, national needs that must be supported by the federal government. Therefore, we need to have moderately stable science budgets. We also need to ensure that young scientists are trained well, and that the institutions that train our scientists are healthy.

Most scientists agree that they need money, but very few scientists believe that their institutions need money. This is why agencies must think about building the institutional base even as they carry out their missions.

So, what is wrong with this decentralized system? The problem is that our national goals change rapidly. If particular fields – and physics is one – are linked to specific goals, then the nation as a whole can be in trouble if the goal changes or disappears.

Our goal on health research has not disappeared. The NIH is moving along, though perhaps not as rapidly as we think. But biomedical research consistently gets more money from Congress than the administration requests.

Fields such as physics, computers, and communications are important for our economic competitiveness. Congress has been willing to support them bountifully for defense purposes, and commercial industry has reaped the gleanings from that harvest. Without the harvest, there would be no gleanings. These fields are suffering as defense budgets decline.

In principle, if we agree that defense spending is going to decrease but these other sciences are very important to other goals, and the NSF could provide the balance. In practice, in an era of tight budgets, NSF will be hard put to do very much extra. Making the best budget decisions in this complex situation is extraordinary difficult, and I do not believe there are simple criteria or simple answers.

We have to focus on major changes. Sometimes we will keep on supporting things we shouldn't for political reasons. In many cases, I don't believe that fighting to be number one makes any sense. I do think being competitive in all major fields is very important.

Within agencies, program managers have to balance one field with another and the present versus the future. After they've done this balance the best they can, I believe that the White House Office of Science and Technology Policy and the Office of Management and Budget should review the situation as a whole.

These reviews must pay attention to what is happening internationally and in industry. And I endorse completely the method of experimentation, review, and seeing what works. Adjustments may have to be made. I wish there were simpler ways of dealing with this, but we have a very complex system. And I believe that we have to look at it in its complexity before we can make any useful decisions.