

Chalk or Cheese?: Ends and Means in Science Policy – *David Hart*

The U.S. faces a perennial challenge that is growing more acute – how to deploy its limited resources to best achieve the very large goals that we hold as a people. There are a lot of these goals: military security, environmental quality, insurance against infirmity and poverty, and so on. My view is that like money, science and technology should be seen primarily as means to achieve these ends, rather than as ends in themselves. My concern is the confusion between means and ends.

The debate over science and technology policy has begun to resemble too much the debate over fiscal policy. In fiscal policy, the nation has gotten caught up in rhetoric about deficit reduction. This has become an end in itself, and we no longer talk about the deficit as a means to achieve economic growth and stability.

Science and technology policy, too, has been marred by confusion between means and ends. This problem can be seen most clearly in discussions about a Department of Science, but I don't think the confusion has been confined to that proposal. This confusion of means and ends distracts us from grappling with the more important problem of choosing well among means. That is really what ought to be engaging our attention. I will return to that later, but first, let me begin by discussing the Department of Science and related ideas.

My argument draws upon a debate among the giants in the history of science policy that was carried out on the pages of *Minerva* about 30 years ago.¹ Michael Polanyi and Alvin Weinberg were some of the participants in this debate. This was a time that budgets were growing by something like 15 percent per year. On that note, we have to marvel at their foresight, to foresee this day and age when we would come to what Derek DeSolla Price called the steady state.

¹ For a sample of this discussion, see Michael Polanyi, “The Republic of Science,” *Minerva* 1:54-73 (1962); Stephen Toulmin, “The Complexity of Scientific Choice: A Stocktaking,” *Minerva* 2:343-359 (1964); and Alvin M. Weinberg, “Criteria for Scientific Choice II: The Two Cultures,” *Minerva* 3:3-14 (1964).

In this debate, Stephen Toulmin proposed what he called the chalk and cheese principle. In a well-structured administration, Toulmin argued, decisions have to be taken among commensurable alternatives, comparing in each case chalk with chalk and cheese with cheese. This principle, Toulmin said, holds in the administration of scientific affairs as forcibly as it does in the rest of public service. His point was not that R&D projects should be compared against one another, but rather that they should be compared against other ways of achieving the goals laid down by political authorities. Although both chalk and cheese are solids that crumble differently, one is for writing, the other for eating. The goal of policy analysis – if I can stretch this metaphor – should be the best writing and eating, not optimizing crumbliness. The latter demonstrates confusion of means and ends.

This confusion of means and ends appears on the contemporary scene in a number of different guises. Take the analysis of total federal R&D spending. Perhaps because so many scientists are recipients of federal funds, I think we have grown into the habit of judging the budget in terms of its year-on-year growth. This mode of assessment appropriately prompts a couple of criticisms. Scientists and engineers are perceived as arrogantly assuming an entitlement that the representatives of the people have not voted, or else they are seen as a classic Washington interest group clutching at the federal purse for no other reason than their own material benefit. In either case, the ends of the spending are not specified.

Another way to analyze federal R&D spending is to add it to private R&D spending and then compare the sum – that is, total national R&D spending as a share of our gross national product or gross domestic product – with that of other nations. When the nation falls behind its competitors on this indicator, the federal government is presumed to have some responsibility to make up the difference. Unlike the first approach, this method typically relates total national R&D to some goal: in the past, military security; more recently, economic growth.

But even though a national goal is specified, I would argue that this approach of taking R&D as a percent of GDP still violates the chalk and cheese principle. If the national goal is economic growth, R&D spending ought to be compared against other policies that might achieve that end, like deficit reduction or demand expansion, rather than comparing it with

the fraction of R&D as a percent of GDP spent by other countries. The question is, to maximize economic growth, would the marginal increment of federal spending best be spent on R&D as opposed to other ways of spending, or not spending it at all? I admit this is a difficult calculation to make, but I think it the way we ought to pose the problem.

The Department of Science concept is equally confused, in my view. The idea of a central institution to manage the nation's science and technology has been traced back to the Constitutional convention by Hunter Dupree. The idea for a Department of Science has been offered up more than a hundred times just since Vannevar Bush, although Bush didn't make exactly the same proposal.

The latest of these proposals was put forward by Representative Robert Walker when he was chair of the House Science Committee. The proposal excluded the bulk of R&D funding, that of the Department of Defense (DOD) and the National Institutes of Health (NIH), but it did include such disparate elements as parts of the Department of Energy (DOE), the Department of Commerce (DOC), the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), the Environmental Protection Agency (EPA), and the U.S. Geological Survey (USGS).

Walker argued that the main mission of these entities is the promotion of science for its own sake. Of course, a brief look at their authorizing legislation, with the exception of NSF partially, shows this is not the case. NASA is supposed to explore space, EPA to protect the environment, and so on. It seems to me that unless Congress has accepted science as an end in itself to a much greater extent than it has, Walker's Department of Science would be little more than a holding company and a juicy target for budget cutters.

The travails of the National Endowments of the Arts and Humanities in recent years suggests that the cultural argument – this is the label that Alvin Weinberg applied to the argument of science for its own sake back in 1964 – is no more politically persuasive now than it was in the past, and perhaps less so.

The last example that I offer as the confusion of means and ends in the contemporary debate is *Allocating Federal Funds for Science and Technology*, a report of the National Academy of Sciences that was chaired by Frank Press (Press 1995). The Press report's central recommendations include the establishment of a federal science and technology budget, as well as executive and legislative institutions to manage it. The main goal of this budget is to assure U.S. world leadership in science and technology. To this end, the budget provides a mechanism to trade off R&D projects across agencies. The Press report's vision is in some ways more ambitious than the Department of Science, since its federal science and technology budget includes NIH, as well as about eight billion dollars of DOD.

It is also more contemptuous of the chalk and cheese principle. The Press report's budget process would deliberately force chalk versus cheese choices while making chalk versus chalk and cheese versus cheese choices harder. For instance, an EPA research program on the diffusion of effluents in ground water would have to compete not only with EPA enforcement spending, as it normally would in the budget process as it is now constituted, but also with hydrologic programs in other agencies such as NSF. The criteria that the Press report endorses for making these kinds of comparisons – that is, between the two research programs – include not only the program's contributions to the missions of these agencies, such as safer drinking water or knowledge of hydrology, but also the processes and instruments by which these funds are dispersed. As I understand it – the criteria aren't exactly transparent in their application – the budget-makers could cut EPA's research funding in favor of NSF in this area with little regard for the EPA's larger program if they determine that EPA failed to consult adequately with the external scientific community, which is one of their procedural criteria.

This is not the proper way to go about these things. The proper way is to apply the chalk and cheese principle. It begins with the specification of federal missions by the President and Congress, the setting of priorities among them, and the establishment of budgets.

Working within these budgets, the agencies determine the appropriate level of investment in science and technology for achieving their missions compared to other kinds of spending, such as direct services, procurement of more conventional goods, and so on. This is

essentially the system that we have. It is a system that has evolved some instruments, like the Federal Coordination Committee on Science and Technology (FCCST) cross-cuts under the Bush Administration, and the National Science and Technology Council (NSTC) working groups under the Clinton Administration that help deal with the duplication that might arise in such a system as well as facilitate interagency programs and deal with international joint ventures, which are becoming more important.

It is not a perfect system, and it has particular failures, most notably the jurisdictions of certain appropriations subcommittees, which can force perverse tradeoffs. Nonetheless, the fundamental design is sound. We ought to continue to work for incremental improvements and select out those experiments like the cross-cuts that adapt the system well to new circumstances, rather than pressing for the kind of wholesale change that Representative Walker or the Press report's proposals would.

In our decentralized system, a major challenge is to get agencies and their political masters to take a long-term view of the mission: when and how it might be achieved, so that, on the margin, R&D spending might be more favored than it is now. In other words, those who believe that science and technology provide powerful means to give the public what it wants must make the case in those terms.

The supporters of biomedical research have done this extremely well, as the NIH budget curve shows. The cold war Defense Department is another example of successful advocacy of mission-oriented R&D, for better or worse.

It isn't always an easy case to make, since the time horizon of most politicians extends only to the next election. It invites the application of dangerously rigid standards of evaluation, even ridicule. Senator Proxmire used to hand out the Golden Fleece award for projects he deemed especially unworthy of federal funding.

Some of our efforts have to be devoted to ensuring appropriate efforts to measure the contribution of science and technology to agency missions. One argument we might make is that these kinds of evaluative measures should be applied to whole programs rather than

individual projects, since we do not know what the outcomes of projects will be in advance. And we might argue that such programs ought to be evaluated in qualitative terms. Perhaps we should also engage the users and beneficiaries of these programs in these evaluations, not merely peer reviewers.

But however difficult these metrics are to devise, and however disadvantaged long-term thinking might be in our political system, these are the terms in which the case ought to be made. We should not exaggerate the difficulty, because, as Senator Domenici has documented, R&D budgets have done pretty well in recent years. Most of the pain is still prospective from the point of view of aggregate R&D spending, though that doesn't always translate down to the individual level of scientists.

What does it take to make this kind of case? It begins with a community with a deep commitment to its cause, that can be mobilized in its support. I think the scientific and technical community has this commitment, although many in it may lack the time for a lobby day in Washington. Scientists, engineers, and science enthusiasts tend to be reasonably wealthy and sophisticated, and they tend to be widely distributed geographically. These are all highly-prized attributes from the point of view of mobilizing a political constituency.

Second, and perhaps most important, the political leadership of the community has got to know how the budget process works, and have a sense of the tactics and timing appropriate to each stage in that process. It must also possess the organizational capacity to carry out these tactics – that is, to turn out its supporters when they are needed.

Finally, the case for mission-oriented science and technology can draw on a deep sense of faith among the public that these investments in science and technology will pay off. I think the fear of an anti-science trend has been greatly exaggerated. In fact, if anything, that audience is too gullible when it wants to believe that something is possible, like the Strategic Defense Initiative.

That's not to say that the nation has been sold a bill of goods by scientists and engineers. Even in the case of biomedical research, according to the NSF, the total public and private spending on biomedical research in 1994 was \$33 billion dollars. That is a lot of money, but remember that the total enterprise is a trillion dollars. About 3.3 percent of this doesn't sound bad to me.

Rather, my point is simply to remind the lobbyists, if I can call the scientific and technical community that, to try to keep expectations reasonable. Convey the promise not of spectacular leaps forward but of broadly diffused pay-offs. I do not believe science and technology can solve every problem, no matter how well funded it is.

A second challenge in a decentralized system of mission-oriented R&D is to achieve an adequate balance between dedicated expertise and flexibility. For missions that are deemed very important and long-lasting, there is no substitute for specialized institutions that cultivate unique knowledge and capabilities. It is impossible to imagine the post-WWII rate of progress in weapons technology without the national laboratories. It is equally impossible to imagine the rate of progress in medical technology without the academic medical centers.

Unfortunately, when public priorities change or when the mission is achieved, like winning the Cold War, these institutions become a burden. The benefit of specialization becomes the burden of rigidity. I think the people in these places can be reoriented, and perhaps some of the equipment as well, but I do not think the institutions and culture that they nurture can be. Rather than try to save them, the proper policy is to reduce or close them in accordance with the new level of mission need, and to facilitate the reemployment of those resources elsewhere on other missions.

If the communities where these facilities are located are mobilized as I have described, closing the facilities can be a pretty difficult job, as we have seen in New Mexico. In these instances, I think it is incumbent upon the S&T community to break ranks, rather than to circle the wagons.

The Press report does a good job of this. It calls for reductions, for instance, in the DOE labs. What it does not do is provide enough of a rationale to articulate new missions to which those resources might be better put in the future. This is especially true for transferring resources to the universities, which I take to be one of the main objectives of the Press report. Its main argument for funding academic scientists is that they are flexible. This calls to mind the Bush report's metaphor of a reservoir of knowledge that can be put to use as new needs emerge. But flexibility is not a mission.

The Press report likewise under-emphasizes the role of academic scientists in education. This mission was fully articulated in the Steelman report (Steeleman 1947), which has tended to take second seat to the Bush report in our histories. It's a mission that resonates with the nation right now. The proper role of the federal government in education is far from settled, but that is all the more reason for the community to be mobilized and to advocate on this point.

The advocacy of education for its own sake comes dangerously close to what I referred to before as the cultural argument. And while I think that that argument has limited appeal – although it may appeal very much to those of us who are academics and would like our students to become broad-minded human beings for their own good – it should not be abandoned. There actually is a reasonable amount of public support for areas of research that don't necessarily have a mission application, such as astronomy and cosmology. But I do not think that we should make too much of the federal role on that cultural argument.

I want to offer an argument that I think has broader appeal, and that is to link education with the economic needs of the next century. It may be conventional wisdom that the economy is based increasingly on technology and innovation, and therefore requires an increasingly skilled and creative workforce. However, the nation has not done very much to act on that conventional wisdom.

Adopting this kind of argument has serious implications for science policy, and we ought to recognize that. It means that the expected future demands of the job market, rather than the opportunities perceived by academic researchers for science, ought to be the major criterion

for allocating funds. It means that teaching ought to be accorded more emphasis and respect.

We can hope that these things will line up – that is, scientific opportunities and job opportunities and teaching excellence and research excellence – but they may not, and all too often in the past, they haven't.

An argument that connects research funding with education for the sake of economic growth – i.e., an economic management mission of the federal government – creates political opportunities for the science and technology community. The Clinton Administration entered with plans to make an array of investments that included R&D but extended also to infrastructure, education, and other sorts of programs. Much of this was abandoned in the name of deficit reduction, and perhaps appropriately so, if I can refer back to the chalk and cheese principle. But in the long run, I think that macroeconomic management is going to be an inadequate substitute for the provision of public goods that make markets work. These kinds of goods, like research and education, are complimentary.

Science for science's sake can be achieved with R&D funding alone. Science for the economy's sake will not pay off without other investments besides R&D. In this respect, the scientific community might be able to join a coalition with labor and business organizations that believe in making these kind of investments for the sake of the economy. We have to remember that there are going to be enemies made along the way, and the process may divide the community. But nonetheless, I think that it is a plausible rationale.

The chalk and cheese principle is not easily applied in the U.S. Our political system is prone to overlapping jurisdictions and turf wars. I submit, however, that this ideal is a more sensible guide for efficiently carrying out the will of the people than simply maximizing federal R&D spending or ensuring that federal R&D spending is done in accordance with the wishes of the scientific establishment.

And it is carrying out the will of the people and participating in the formation and refinement of that will that ought to be the object of the science and technology policy community.