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Science's Social Effects

We need to explore the possibility of a new ideal of "impure" science, in which scientists and engineers both educate and learn from others about the relation between science and society.

In 2001, the National Science Foundation (NSF) told scientists that if their grant proposals failed to address the connection between their research and its broader effects on society, the proposals would be returned without review. The response was a resounding "Huh?"

It's time we faced facts. Scientists and federal funding agencies have failed to respond adequately to a reasonable demand from Congress and the public. The demand: Researchers and their tax-supported underwriters must take a comprehensive look at the broader implications of their science in making decisions about what research to support.

There are exceptions, but scientists and engineers generally have had a difficult time meeting this merit review criterion. Yes, the quantity of responses to what is called the "broader impacts criterion" has risen steadily. But the quality of those responses remains a persistent problem. In order to improve the quality, we need a more interdisciplinary approach to generating and reviewing grant proposals.

In theory, it might be reasonable to think this problem could be addressed by teaching scientists and engineers how to assess the broader effects of their research. In practice, however, such attempts have led to the widespread view that intellectual merit is the primary and scientific criterion, and that broader impacts is a secondary and minor "education" criterion. Too often, the responsibility for satisfying the broader impacts criterion has been taken over by education and public outreach (EPO) professionals. They are hired to facilitate education activities for scientists, who are trained chiefly in science, not in education.

This approach allows scientists to conduct their research on their own while the EPO professionals take care of education and outreach. But it reinforces the idea that research in science and engineering is separate from education in science and engineering; an idea that runs counter to one of the main motivations behind the broader impacts criterion, which is that scientific research and education can and should be integrated.

To our knowledge, all NSF-sponsored workshops in 2005 and 2006 that offered advice to scientists on how to address the broader impacts criterion focused on broader effects only in terms of education and outreach. The danger inherent in this approach is that education and outreach are liable to emphasize a triumphalist view, highlighting only the striking advances of science and technology. This approach does not reflect on the larger moral, political, and policy implications of the advance of scientific knowledge and technological capabilities. Granted, education and public outreach are important elements of the broader impacts criterion. But without equal consideration of the ethical, political, and cultural elements of science, the focus on education and outreach threatens not only to absolve scientists and engineers of the responsibility to integrate their research and education activities, but also to turn the broader impacts cri-

terion into an advertisement for science and technology.

One can hardly blame EPO professionals for marketing themselves as experts who can help with issues of broader effects. Unfortunately, however, EPO professionals have now come to be viewed as the group uniquely qualified to help scientists confused about how to satisfy the broader impacts criterion. EPO activities focus on issues such as expanding the participation of underrepresented groups (for example, by facilitating campus visits and presentations at institutions that serve those groups), enhancing research and education infrastructure (for example, by contributing to the development of a digital library), disseminating research more widely (for example, by developing a partnership with a museum or a science and nature center to develop an exhibit), and benefiting society (for example, by interpreting the results of specialized scientific research in formats understandable for nonscientists).

It is simply a misinterpretation of the broader impacts criterion to label it the education criterion. It would make more sense to place science in its larger societal context. Take, as just one example, the goal of increasing the participation of underrepresented groups. That goal is not fulfilled solely by giving presentations at minority-serving institutions or by including a woman or minority group member on the research team. It should also involve giving some thought to why diversity is important to scientific research (for example, by exploring Philip Kitcher's ideal of well-ordered science or David Guston's calls for the democratization of science). The danger is that without such reflection the goal of increasing minority representation will simply appear as another case of identity politics.

It is, of course, true that scientists simply don't have time to read philosophy or studies of science. But they don't have time for reading educational theory either, yet sensitivity to questions of teaching remains part of the science portfolio. The same should be true of the ethical and policy implications of their work.

EPO professionals have taken it upon themselves to engage scientists on the level of science's broader educational effects. We applaud this as long as scientists and engineers participate in EPO activities rather than treat EPO professionals as separate subcontractors. Instead of allowing EPO professionals to shoulder the sole burden of articulating science and technology's broader effects, more of us ought to share the load. Integrating research and education is a worthy ideal that NSF is concerned to promote, but it hardly exhausts the possibilities inherent in the broader impacts criterion, which encompasses issues such as the democratization of science, science for policy, interdisciplinarity, and issues of ethics and values.

The challenge facing NSF, and the scientific and technical communities generally, is that disciplinary standards of excellence alone no longer provide sufficient warrant for the funding of scientific research. Put differently, Vannevar Bush's 1945 model for science policy has broken down at two crucial points. First, it is no longer accepted that scientific progress automatically leads to societal progress. As long as this belief was the norm, disciplinary standards within geophysics or biochemistry were sufficient for judging proposals, and the wall separating science from society could remain intact. Second, and following from the first, recognition of the inherently political nature of science has become an accepted part of the landscape. But the point is not that science is subjective; science and engineering daily demonstrate their firm grasp on reality, even if the old dream of scientific certainty has faded, at least for the scientifically literate. No, the point is that science is deeply and inescapably woven into our personal and public lives, from the writing of requests for proposals to decisions made at the lab bench to the advising of congressional committees.

Unlike EPO professionals, researchers on science—historians and philosophers of science, policy scientists, and researchers in science, technology, and society studies—have generally failed to recognize the broader impacts criterion as an opportunity. We have built careers by reflecting on the broader effects of science and technology, but we have offered little help to scientists and engineers perplexed by the demand to assess and articulate those broader effects. Humanists and social scientists who conduct research on science, especially research on the relationship between science and society, should seize the opportunity the broader impacts criterion presents. We should work with scientists to help them reflect on and articulate the broader effects of their research. We should follow the example of EPO professionals, becoming facilitators in the assessment of the effects of research. But we should do so by instilling a critical spirit of reflection in scientists and engineers.

For their part, scientists should embrace, not merely meet (or even attempt to avoid) the broader impacts criterion. We philosophers believe that publicly funded scientists have a moral and political obligation to consider the broader effects of their research. To paraphrase Socrates, unexamined research is not worth funding. But if calls to duty sound too preachy, we can also appeal to enlightened self-interest. Agency officials, from the NSF director on down, are constantly asked to explain the results of the funding NSF receives and distributes. A fresh set of well-thought-out accounts of the broader effects of last year's

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funded research is likely to play better on Capitol Hill than traditional pronouncements about how investments in science drive the economy and are therefore necessary to insure the U.S. competitiveness.

Sadly, there is little evidence that proposals deemed strong in terms of the broader impacts criteria find themselves at any significant advantage over proposals that are weak on those topics. Often, the criterion is used as a sort of tiebreaker in cases in which reviewers must decide between proposals of otherwise equal intellectual merit. Although in principle there isn't a problem with occasionally using this approach, tiebreaking is not the criterion's only function.

To encourage scientists and engineers to use the broader impacts criterion to its fullest, NSF should include an EPO professional and a researcher on science both as individual reviewers of proposals and as members of review panels. Such an approach—particularly in the review panels, in which researchers from different disciplines interact with each other—will encourage all reviewers to be more responsive to the broader impacts criterion. This, in turn, will encourage scientists and engineers to be more concerned with the broader effects of their research. Scientists and engineers will be motivated to seek out both EPO professionals and researchers on science to work together on grant proposals. The result? The kind of integrated and interdisciplinary research NSF seeks to support.

Scientists may view these suggestions as attempts at politicizing the (ideally) value-neutral pursuit of science. We suspect that such a reaction may underlie many scientific and technical researchers' resistance to the criterion, as if assessing and articulating the broader effects of scientific and technical research were somehow outside science and engineering. It's as if the criterion somehow represents outside interference in science.

We also suspect that one reason EPO professionals have been so successful in engaging scientists and engineers on broader effects is the widely shared view among scientists that any resistance on the part of the public to the advancement of science and technology is simply due to lack of science education. The public certainly ought to know more about science and technology, but there is little evidence that universalizing scientific and technological literacy would by itself produce a wholly supportive public.

If society needs to be educated about science and technology (and it does) scientists and engineers, too, need to be educated about the effect of science and technology on society, as well as the effect of society on science and technology. The broader impacts criterion represents an excellent (perhaps the best) opportunity for scientists, engineers, researchers on science and technology, policymakers, and members of the larger society to engage in mutual education. This promise will be fulfilled only if scientists, engineers, EPO professionals, and researchers on science work together and use the criterion to the fullest.

Finally, concern with the criterion should go beyond helping NSF improve its merit review process, and even beyond helping NSF achieve its larger goals of integration and interdisciplinarity. Insofar as science and technology have effects on our society, asking scientists and engineers to consider and account for those broader effects before they commit themselves to a particular research program, and before taxpayers commit to funding that program, sounds eminently reasonable. This is not to suggest that members of the public should have the final say on every funding proposal. It is to suggest, however, that publicly funded science should not always be judged only on its scientific merit by scientists. We need to explore the possibility of a new ideal of impure science, in which scientists and engineers both educate and learn from others about the relation between science and society.

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