

# BEYOND THE DATA

**The latest attempt to clarify how NSF assesses grant proposals for possible impacts beyond the expected scientific results has not ended a long-running debate**

**THE NATIONAL SCIENCE FOUNDATION** (NSF) uses two criteria to judge the 55,000 grant proposals it receives each year. One is straightforward enough: intellectual merit. But the other, known as “broader impacts,” is so confusing that a cottage industry has sprung up to help scientists figure it out.

For only \$79—marked down from \$197, according to one recent e-mail—a company in Florida offers a CD that teaches applicants how “to successfully identify, distill, and communicate your project’s broader impacts to NSF reviewers, improving your chances of funding.” For those scientists on a tight budget, there are plenty of free tips in the open literature.

The phrase is intended to help NSF determine whether the cutting-edge science being proposed is also addressing an important societal issue. It was adopted in 1997 to rebut criticism that the basic-research agency cared more about the interests of the academic community it serves than the needs of the taxpayers who ultimately foot the bill for its programs.

The National Science Board, NSF’s presidentially appointed oversight body, would like to put that cottage industry out of

business by explaining once and for all what NSF means by broader impacts. In June, a board task force took a stab at drafting a new set of principles for reviewers and applicants to follow. Instead of clearing the air, however, the draft guidelines generated a fresh wave of protest. (See page 170 for excerpts from a few of the 265 e-mailed comments. NSF also gathered feedback in meetings with and surveys of stakeholders.)

The task force has taken that criticism to heart and is busy revising the guidelines. “It’s our attempt to be frighteningly clear,” task force member Alan Leshner (CEO of AAAS, which publishes *Science*) explained during a meeting last month of the task force. “But if we’re not, we need to know that.”

### **An elusive definition**

NSF has been anything but clear over the years about the meaning of broader impacts. Officials steadfastly refused to provide a precise definition, for what they believed to be a good reason: Such a statement might stifle innovative thinking about the myriad ways research can benefit society.

“So many people have interpreted the broader-impacts criterion as requiring something involving K–12 education,” says Cora Marrett, deputy NSF director and former head of NSF’s education directorate. “But that’s not our position at all.” Pinning down the scope

of broader impacts could actually be counterproductive, she adds. “Efforts to find activities that are universal may be totally inappropriate for a particular field, or project, or individual PI [principal investigator],” Marrett says, “because people may

not have the special expertise needed.”

Working to improve STEM (science, technology, engineering, and mathematics) education at all levels is certainly one way to demonstrate a commitment to broader impacts. But so are activities aimed at attracting and retaining more women and minorities and, more generally, training the next generation of scientists. Strengthening the nation’s scientific infrastructure through increased collaborations and the sharing of equipment and facilities would qualify, as would many types of public outreach. Over the years, NSF has also looked favorably

### **Online** **sciencemag.org**

Podcast interview  
with author  
Jeffrey Mervis.

upon researchers who hope to commercialize their discoveries with the goal of boosting the economy, improving national security, protecting the environment, and enhancing the general well-being of society.

Since the second criterion was adopted, however, NSF officials have complained that significant portions of the community are either ignoring or not taking it seriously. In 2002, a frustrated NSF Director Rita Colwell tried to crack the whip. “NSF will return without review proposals that do not separately address both merit review criteria within the Project Summary,” she declared in a bulletin to the community.

Confusion persisted, however. Merit review at NSF is a complex process, involving panels made up of thousands of volunteer reviewers guided by hundreds of NSF program officers. And scientists say that no two panels follow exactly the same definition of broader impacts.

So in 2007, NSF tried a new tack. It described five “representative activities” that would qualify as having a broader impact. Four of them were familiar: promoting teaching, training, and learning at all levels; broadening participation of groups underrepresented in science, notably women, non-Asian minorities, persons with disabilities, and those at institutions outside the scientific mainstream; enhancing the research and education infrastructure through increased collaborations; and disseminating knowledge of science and technology to the general public. The fifth activity, listed under the heading Benefits to Society, serves as a catch-all category for activities such as advising government agencies, working with industry, and putting data into a format that nonscientists can understand. Last year, Congress waded into the fray, asking NSF to explain what it means by broader impacts and how it plans to ensure compliance.

#### **No-go on national goals**

The science board’s June draft tried to answer that question. It began by laying out four principles underpinning merit review, the most notable being a statement that “NSF projects should help to advance a broad set of important national goals.” That assertion is followed by a list of nine examples of activities that would qualify as demonstrating broader impacts. The list began with “increased economic competitiveness” and included “increased partnerships between academia and industry” and “increased national security.” Another principle declares that “broader impacts may be achieved through the research itself, through activities

that are directly related to specific research projects, or through activities supported by the project but ancillary to the research.”

The list of national goals drew sharp and bimodal criticism. One segment of the community complained vociferously that the new language would undermine efforts to promote NSF’s historical commitment to diversity, improving instruction, and raising public literacy. They feared that those goals, previously the centerpiece of the broader-impacts criterion, would become subservient to the

hunt for an economic payoff. Another group, less vocal but equally critical, told the task force that it had lost sight of the importance of basic research. Some even worried that asking applicants to describe how they planned to satisfy the broader-impacts criterion might corrupt the merit-review process itself.

Recognizing that its first draft had fallen short, the task force scrapped it and began working on a new version. Although the task force has not made public a copy of its latest draft, John Bruer, president of the James

## THE COMMUNITY WEIGHS IN ON BROADER IMPACTS

“The new criteria shift from a strong, clear expression of a commitment to preparing and engaging a diverse domestic scientific workforce to the downgrading of diversity to be one of nine possible methods of demonstrating broad impact. . . . I have no doubt that this change will dilute the impact of NSF on access and representation in science and engineering.”

—JANET WEISS, DEAN AND VICE  
PROVOST FOR ACADEMIC AFFAIRS,  
UNIVERSITY OF MICHIGAN,  
ANN ARBOR

“The broader impacts should carry weight only as an extra benefit, an additional positive feature of a proposal. A person should be allowed to say that there are no broader impacts envisioned and still get funding if the science is visionary and outstanding.”

—STEPHEN LEONE, PROFESSOR OF  
CHEMISTRY AND PHYSICS,  
UNIVERSITY OF CALIFORNIA,  
BERKELEY

“Making the stated [and laudable] national goals an explicit funding criterion amounts to apologizing for scientific research rather than leading the fight in support of it. . . . Proposals for funding of basic science will only address these criteria if the proposer is insincere but convincing and the responsible program director is insincere in reading that part of the proposal.”

—BORIS HASSELBLATT, CHAIR OF THE  
MATHEMATICS DEPARTMENT,  
TUFTS UNIVERSITY IN MEDFORD,  
MASSACHUSETTS

“We recommend that the third national goal be removed from the list and included as a separate principle [to wit]: Broadening participation is a key to achieving the national goals, and investigators must include mechanisms in their broader impacts.”

—ANN GATES, ASSOCIATE VICE  
PRESIDENT OF RESEARCH,  
UNIVERSITY OF TEXAS, EL PASO,  
ON BEHALF OF THE COMPUTING  
ALLIANCE FOR HISPANICS

S. McDonnell Foundation and chair of the task force, agreed to talk with *Science* about its key provisions.

A major change is a reconfiguration of the section that lays out the overriding principles for merit review. Instead of four principles, with the list of national goals featured prominently, there are three governing ideas, none as controversial as the goals list. The first declares that all NSF projects “should be of the highest quality.” The second says that, in the aggregate, projects should contribute more broadly to advancing societal goals. The third states that any assessment of a project’s broader impacts should be “scaled” to the size of the activity.

“The original list of national goals ... was

actually intended to describe a set of outcomes,” Bruer says. “Listing them as a guiding principle created some concerns within the community that we have addressed in the new version.”

The emphasis on top-quality research in the first principle, Bruer says, should assuage those who fear that the broader-impacts criterion “would dilute NSF’s commitment to excellence in research.” The second principle, he adds, explains “how broader impacts might be achieved. We want to make clear that it’s not seen simply as an additional activity on a grant but rather that it is an essential component of the research activities.”

Bruer said it may turn out that broader impacts are best measured “in the aggregate.”

Some types of NSF-funded activities and programs, such as large centers or collaborations with industry, “are explicit about how broader impacts will be evaluated.” But that’s not the case for standard grants to individuals. “Principal investigators have tried to respond in good faith and devote appropriate resources to these activities,” he says. “But it may be more appropriate to measure them at the portfolio level of an NSF directorate, or perhaps across an entire university department or institution.”

Bruer didn’t rule out soliciting another round of public comments. But he hopes that the full board will embrace the task force’s report at its next meeting, in December, and he says that posting another draft “might push back that time frame.” —JEFFREY MERVIS

“The criteria as modified are troubling. Those supported by the NSF must be held accountable to the society that supports them, not just to those that look like the majority of scientists [white and male] awarded grants from mostly research-intensive universities.”

—MARIA ELENA ZAVALA,  
PROFESSOR OF PLANT BIOLOGY,  
CALIFORNIA STATE UNIVERSITY,  
NORTHRIDGE

“Forcing PIs to devote time, energy, and resources toward outreach activities, one NSF grant at a time, in an uncoordinated fashion with other efforts, is highly wasteful of resources. Many PIs are not well-qualified, well-suited, or highly motivated for K–12 outreach, public outreach, et cetera.”

—ROBERT CARPICK, PROFESSOR OF  
MECHANICAL ENGINEERING AND  
APPLIED MECHANICS,  
UNIVERSITY OF PENNSYLVANIA

“It is very difficult to do first-rate science, and very time-consuming. It is therefore unreasonable that NSF demand its PIs spend time and energy on activities peripheral to the research they are proposing as a condition for receiving support.”

—PETER MOORE, PROFESSOR  
EMERITUS OF CHEMISTRY,  
YALE UNIVERSITY

“I have always valued the older construal of the broader impacts criterion, i.e., the value of outreach, the inclusion of different educational institutions, and the purposeful attention to supporting and bringing in women and members of underrepresented groups. I believe that important focus is hidden, and even lost, in the proposed guidelines.”

—BIANCA BERNSTEIN, PROFESSOR OF  
COUNSELING PSYCHOLOGY,  
ARIZONA STATE UNIVERSITY,  
TEMPE

“Much of the research in my field [computer sciences] has significant impact on other fields, on national security, and on economic competitiveness. Yet my field has a terrible record for the inclusion of women and minorities, and a terrible record for K–12 impact. To include [those goals] as broader impacts gives researchers in my field an unconscionably cheap way to satisfy this criterion.”

—ED LAZOWSKA,  
PROFESSOR OF COMPUTER SCIENCES,  
UNIVERSITY OF WASHINGTON, SEATTLE

“It is not clear to me how a merit-review panel could decide how one PI’s goals and aspirations for broader impacts are more likely to succeed than another’s. ... This uncertainty contrasts sharply with the clarity with which intellectual merit can be evaluated.”

—GORDON LOGAN, PROFESSOR OF  
PSYCHOLOGY, VANDERBILT UNIVERSITY  
IN NASHVILLE.