



## Resources

### NSF Update: Investing in the Ideal University

(From the November 1997 issue of ASEE PRISM)

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*The National Science Foundation plans to fund more projects that emphasize two areas it believes encourage academic reform: the integration of research and education, and interdisciplinary research.*

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When the National Science Foundation announced in late 1996 that reviewers in its merit review system would receive a new set of criteria upon which to base their decisions about who receives research funding, university researchers nationwide wondered what this would mean to their research and their universities. NSF officials repeatedly assured academe and the public that the new criteria did not signal a decline in research and development quality or quantity, but instead would lead to greater efficiencies.

The changes in merit review criteria came partly as a result of a congressional push in the early 1990s to force federal agencies such as NSF to make several changes in how they conduct business. The domestic discretionary budget (where engineering and science research, development, and education programs are funded) was declining; universities could no longer rely on the steady increase in federal funding to which they were accustomed during the nearly 50 years of the Cold War. While the budget was shrinking, Congress began demanding greater accountability for projects supported by federal agencies. With the passing of the 1993 Government Performance and Results Act (GPRA) and the Clinton Administration's National Performance Review (NPR) program (best remembered as Vice-President Gore's fight against government waste), the government demanded that its agencies find ways to do better work at lower cost.

NSF, in preparation for GPRA compliance, which required each federal agency to create a five-year strategic plan by September 1997, issued a series of reports outlining various changes, including the one on merit review criteria changes. The new criteria, which took effect October 1, 1997, replaced the previous four criteria with a set of only two. The old criteria asked reviewers to consider: 1) research performer competence; 2) intrinsic merit of the research; 3) utility or relevance of the research; and 4) effect on the infrastructure of engineering and science.

The new criteria simply ask: 1) What is the intellectual merit and quality of the proposed activity? and 2) What are the broader impacts of the proposed activity? NSF officials say these criteria are clearer and easier for reviewers to understand, and therefore should make the entire merit review system more efficient.

They also claim that the larger breadth of the new questions gives program directors and reviewers the ability to fund more projects that fall under two areas NSF believes encourage academic reform, and so is emphasizing in its strategic plan: the integration of research and education, and interdisciplinary research. This article describes ways NSF is stressing these two areas, and provides suggestions from NSF staff members on what researchers need to consider when trying to secure an NSF grant.

### Integrating Research and Education

As previously stated, one anticipated result of the revamped merit review criteria is an increased emphasis on integrating education and research, or "discovery and learning," as much of the NSF literature puts it. This paragraph from a February 1996 NSF press release sets the scene. . . .

*Picture an ideal university: It has a pervasive culture promoting collaborative research between professors and students; there are Internet links between research labs, libraries, and students; and there is an emphasis on discovery-based learning techniques throughout science and engineering curricula. This should be the norm. Often, however, it is not.*

NSF is taking steps agency-wide to steer more universities toward this ideal image. Testifying before a congressional subcommittee in April, NSF director Neal Lane said that the integration of research and education is a "core strategy from the foundation's strategic plan [that] has emerged as a key touchstone for all NSF investments. Educating today's students in a discovery-rich environment will better prepare them to meet tomorrow's challenges. Likewise, history has shown that research in an education-rich environment yields an exceptionally dynamic and diverse enterprise."

Besides establishing new merit review criteria, NSF introduced a new set of awards in 1997 to recognize those universities that have made progress toward this goal. Called the Recognition Awards for the Integration of Research and Education (RAIRE), these awards identify and recognize research-intensive universities that effectively promote the integration of research and education. There were 10 first-year award recipients: the Universities of Arizona, Delaware, Michigan, Missouri, and Oregon; Carnegie Mellon University; Duke University; Kansas State University; the University of California, Los Angeles; and the State University of New York at Stony Brook. Each RAIRE recipient receives \$500,000 over a three-year period to continue innovative work in linking discovery and learning and to promote awareness nationwide via articles, reports, Web sites, and workshops.

David Schindel, senior science advisor in the Office of Science and Technology Infrastructure at NSF, which runs the RAIRE program, says, "Part of the award funds are to be spent on documenting and disseminating information on these model approaches. NSF is doing more than just identifying them. We want the rest of the higher education community to be able to learn about these approaches and consider adopting similar practices locally."

The RAIRE awards are just part of NSF's effort to make the linkage between research and education a core part of its university funding. NSF funds other programs in which the integration of research and education is a key strategic goal:

- » The Faculty Early Career Development (CAREER) Program supports junior faculty members in their efforts to develop careers that balance and integrate research and education.
- » Research at Undergraduate Institutions (RUI) provides research and equipment support to faculty at predominantly undergraduate institutions. RUI proposals must highlight the educational impact of the research activities.
- » The Research Experiences for Undergraduates Program (REU) supports undergraduate student involvement in hands-on research activities, either through supplements to existing research grants or through special awards for group research experiences. All NSF disciplinary research divisions provide funds for these undergraduate research experiences.
- » The Grant Opportunities for Academic Liaison with Industry (GOALI) Program is an NSF-wide activity that supports a variety of industry-university partnerships that create opportunities for faculty members, postdoctoral fellows, and students to conduct research and gain experience in an industrial setting. GOALI also supports development of innovative industry-university educational programs.
- » The Combined Research-Curriculum Development Program supports the incorporation of recent research advances in important areas of technology into

upper-level undergraduate and graduate engineering curricula.

- » The Engineering Education Coalitions Program supports the research and development of innovative and comprehensive models for the reform of undergraduate engineering education.

NSF also funds programs whose mission, while not principally the linkage of education and research, still include it as a key focus. Most important to engineering education are the NSF Engineering Research Centers (ERC). A special feature of the ERC program is the emphasis on undergraduate participation in research. Each of the ERCs has one or more programs through which undergraduates from the host institution are engaged in center research projects.

## A Focus on Interdisciplinary Research

The new merit review criteria also reflect a change that has taken place at NSF over the past decade: the rise of interdisciplinary research. Sue Kemnitzer, deputy director of the Engineering Education and Centers Division, said that "while Director Lane and Deputy Director Joseph Bordogna have definitely talked up interdisciplinary research over the past few years, I think it's something that program directors would have probably [funded] anyway. Things were already headed toward interdisciplinary research funding, because that's where the most interesting work is being done."

Because the old merit review criteria asked reviewers to primarily consider research performer competence (based, presumably, on past performance) and the intrinsic merit of the research, it was often difficult for younger researchers, doing work in new, interdisciplinary fields, to receive funding. The new criteria ask simply for the intellectual merit and quality of the proposed activity, which leaves more room for NSF to award grants to those conducting cutting-edge research at the interface of disciplines.

Nearly all of NSF's divisions fund interdisciplinary projects. Some programs even require that research be interdisciplinary. For example, the Integrative Graduate Education and Research Training Program (IGERT), which funds the development of innovative, research-based graduate education and training activities, looks only for projects that, according to the program announcement, are based upon a "multidisciplinary research theme." Additionally, this year the Engineering Directorate began allotting more than \$4 million to finance about 10 projects that support small interdisciplinary research groups.

Christina Gabriel, until recently the acting deputy assistant director of NSF's Engineering Directorate and now the vice-president for research and technology at Case Western Reserve University, says that "what NSF has been seeing over the past decade or more is that the most exciting and important problems in science and engineering research and education are arising at the boundaries between the traditional disciplines. So our choice of budget emphasis should reflect the need to explore those areas."

One problem with taking this tact, Gabriel says, is that in this era of tighter budgets for research and development, it is possible that funding new research areas may come at the expense of funding in more traditional disciplines.

Another problem for NSF may be finding qualified reviewers for the merit review process. Research in some of the interdisciplinary fields is so new, as are the researchers performing the activities, that NSF can no longer choose reviewers from just large fields of established experts; in these new focus areas, there are no "established" experts.

Gabriel admits that "it is more difficult to find a set of people to evaluate proposals addressing broad themes in these new, nontraditional areas, but program officers try to gather a balanced set of reviewers so that: a) they each cover the parts they know individually, and then the program officer synthesizes these to develop an overall review result; or b) they serve on a review panel as a team and work out an assessment of quality together. The review process probably looks about the same on paper as it always did, but NSF program officers need to be more proactive in these more innovative areas to choose reviewers who have expertise beyond a narrow traditional discipline."

## What Should Researchers Seeking Funds Keep in Mind?

There are, of course, no surefire ways to guarantee funding for a project, but it seems safe to conclude that if a project includes a linkage between discovery and learning, or if it addresses a problem at the crossroads of disciplines, it stands a better than average chance of acceptance.

With regard to linking discovery and learning, Mary Hanson, head of NSF's Media and Publications Section, says that, "educational reform, specifically an effort to make research part of a whole [educational process] rather than a separate entity, is what is needed in these times of lower budgets and increased international competition. We need to ensure that we are training the next generation of researchers so that groundbreaking research is being done in the future as well as today. We're trying to nudge engineering and science researchers in this direction; we want to fund their projects, but we want them to seriously think about integrating the educational and research aspects as much as possible. This is what's important to us, and if they're smart, they'll do it."

Cristina Gabriel adds that "those seeking NSF funding should become as familiar as they can with how the process works. They should communicate with the program officers closest to their areas of expertise, and preferably visit with NSF staff in all the relevant funding programs to discuss their long-term research directions and proposal concepts. They should volunteer to serve as reviewers, especially on a panel where they can meet others in related fields. They should make sure that their university encourages faculty members to compete for program officer positions and allows them to take two to four-year leaves of absence to serve their colleagues" by working at NSF in Arlington, Virginia.

While NSF's new merit review criteria may not be revolutionary, they do reflect NSF's recent changes in priorities. NSF wants to move to the forefront of educational reform and cutting-edge, problem-solving research, and by offering funding to projects that incorporate those ideals, it is trying to bring the nation's universities along with it.

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