

INTRODUCTION

The National Science Foundation (NSF) receives about 30,000 proposals a year from the science, engineering and education community. A significant number of these proposals support individual investigators or small groups of investigators engaged in research activities at approximately 2000 U.S. colleges and universities. Through a research proposal, an investigator proposes a project, specifies methods for achieving the project goals and the broader implications of the project including mentoring or educational activities, evaluating the findings, and making them known to all who need to know. The investigators, often in consultation with their institutions, propose the costs and the duration of the project. Unlike other federal agencies that have specific research objectives, NSF is the only agency charged with supporting and strengthening all disciplines across the science and engineering frontier. NSF plays another unique role in that awards integrate research and education activities. Consequently, NSF research proposals, shaped by the proposer's research and educational agenda, the proposer's estimated cost and duration, and addressing all of science and engineering, are varied and diverse. Subsequent research awards sustain the Nation's academic science and engineering research enterprise and its continuing expansion of the boundaries of knowledge, nurture and catalyze emerging opportunities in science, mathematics, and engineering, enable multidisciplinary advances, and provide fertile educational and training opportunities for the Nation's future scientists and engineers.

The NSF research awards, based on the proposals submitted by investigators, remain a principal tool for the NSF to accomplish its strategic mission. This mission, outlined in NSF's strategic plan, emphasizes outcome goals for NSF's investments in people, ideas and tools, and describes the three core strategies -- developing intellectual capital, integrating research and education, and promoting partnerships. In particular, NSF seeks outcomes that provide the nation with a "diverse, internationally competitive and globally engaged workforce of sciences and engineers" and "enable discovery across the frontier of science and engineering, connected to learning, innovation, and service to society." Thus, the investigator research proposal is fundamental to the NSF mission.

The NSF continues to innovate and reform its management and review of proposals through electronic business practices and the electronic submission of proposals, through customer service "time to decision" improvements on review and recommendation, through use of merit review criteria, and through examination of proposal review processes. NSF has recognized that the NSF's research award sizes and award durations, based on proposal requests, may not be fully meeting the nation's needs for 21st Century science and engineering.

"It is urged that the size of NSF grants be examined. Many believe that on average, NSF individual research grants are too small. Examination of separate fields and wide consultation within the community would help in understanding the issues. We favor research grants sufficient to do the work for which the grant is awarded." *Report of the National Science Board on the Future of the National Science Foundation, 1992*

"A significant aspect of NSF's activity is providing resources that 'enable' investigators to undertake and complete specific projects. 'Enablement' is a complex set of factors including not only individual grants, but access to human resources and infrastructure (instrumentation, facilities, research platforms, and databases) that, taken together,

provide the total resources needed to complete a research project. Members of various NSF advisory bodies have called into question, most recently in the NSB Commission's report [above], whether NSF grants 'enable' the investigator to complete the work for which a grant is awarded." (Internal NSF draft report by working group)

In the spring of 2001 the NSF undertook an internal survey (by Division) of investigator research in the science and engineering areas. This internal survey identified wide-spread concerns that current award size and duration did not adequately support the nation's research needs and the NSF mission. The following questions were asked:

- Do awards allow investigators to maintain U.S. leadership in science and engineering?
- Does the *requested budget and duration* of a research proposal describe the actual needs of the research activity since the requested budget and duration may reflect perceptions of "acceptable" award size or duration held by the research community, the reviewing community or historical agency funding patterns rather than actual research needs?
- Do awards provide the important resources necessary to address research complexity required by more collaborative research modes?
- Do awards address the demand for sophisticated laboratory and 'desk-top' technology and computational power?
- Do awards allow increased teamed and multidisciplinary research activities of both national and international nature?
- Are there appropriate and different investment levels for the different types of NSF research grants?
- Do awards provide appropriate educational and training support for future scientists and engineers? For example, is support adequate for the training opportunities necessary for postdoctoral scholars to master interdisciplinary research and for improved educational opportunities for graduate and undergraduate students arising from more stable support mechanisms?
- Is valuable research time of the investigator lost through frequent proposal submissions requesting renewed support or additional support?
- Do current awards provide an opportunity to undertake larger-scale research activities requiring longer duration or greater risk?
- Do awards allow disciplinary-trained scholars the opportunity to undertake interdisciplinary research activities?

The NSF concluded that it is vital to understand current investigator's and institution's point of view of what improvements or efficiencies could be introduced through modifications of the budget and duration of principal investigator research awards. This conclusion was reinforced by the President in the FY 2002 budget:

"With the assistance of the U.S. academic research institutions, NSF will develop efficiency measures of the research process and determine what is the right grant size for the myriad types of research the agency funds" *A Blueprint for New Beginnings, A Responsible Budget for America's Priorities*, February 28, 2001, page 161

In FY 2001 and FY 2002, the NSF, with the consultation and advice with the Office of Management and Budget, contracted for an independent survey to be developed and conducted by Mathematica Policy Research, Inc. to examine the above issues. Mathematica Policy Research, Inc. designed measures and conducted pretests, conducted focus groups, conducted the surveys, and provided to the NSF the attached analysis and report. Two studies were proposed:

(1) A survey of principal investigators having received competitively reviewed research awards in FY 2001, and (2) A survey of academic research institutions.

The survey of research awards consisted of over 6000 principal investigators supported by FY 2001 awards. The web-based survey developed and conducted by Mathematica Policy Research, Inc. achieved an astounding response rate of over 91%. Mathematica Policy Research, Inc. provides the following report on the quantitative aspects of the principal investigator responses.

This report summarizes how principal investigators view issues related to award size and duration, the efficiency of the funding process, the role of NSF in the nation's research enterprise, the human resource outcomes. It also improves the understanding of how science and engineering research is conducted.

Three survey questions provided an opportunity for the investigators to write in detail of their experiences. These qualitative responses proved so rich and extensive¹, that the NSF commissioned a second contractor to provide an independent analysis of the investigator responses. Contractor Deborah Shapley provides a qualitative summary of the responses, "Ruts in The Royal Road", that complements Mathematica's analysis of the multiple-choice survey questions.

¹ Question 2.5 received 1401 responses, Question 3.8 received 2202 responses, and Question 5.14 received 2548 responses.