

AC 2009-840: SUPPORT FOR FACULTY WRITING PROPOSALS TO NEW INVESTIGATOR PROGRAMS

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Support for Faculty Writing Proposals to New Investigator Programs

Abstract

Research grants aimed specifically at junior faculty and new investigators, such as the National Science Foundation Faculty Early Career Development (CAREER) Program, Department of Defense Young Investigator and Beckman Young Investigator grants, can provide a significant boost to an early career faculty's research program. However, these grants are highly competitive and are generally more difficult to write than other research grant proposals, since they often involve a career development plan, an education plan, and other strategic components integrating research and education efforts, in addition to a solid and innovative research project. The Texas A&M University Office of Proposal Development and the Texas Engineering Experiment Station Office of Strategic Research Development, both within the Texas A&M University System, work together each year to present a seminar on how to write competitive proposals for grants specifically for junior faculty. In addition, these offices assist junior faculty individually in planning and writing those proposals, with an additional goal of helping faculty to improve their overall grantsmanship skills. This effort has been successful in engaging faculty, increasing submissions to these programs, and increasing the overall number of these grants awarded to the institution. In this paper targeting junior faculty and new investigators we will discuss common features of these kinds of proposals, how they differ from other research proposals, how agency culture and strategic plans affect grant development, common features of successful proposals, and common proposal pitfalls. We will also discuss how departments and universities can best support junior faculty in their efforts to compete for these grants, by creating an infrastructure for faculty development and engaging and interacting efficiently and effectively with faculty. The model of workshops and seminars to distribute information and create awareness, followed by one-on-one meetings, including critical review of the proposal drafts, has worked well at Texas A&M.

Characteristics and Common Features of New Investigator Programs

New investigator awards are offered by most research funding groups, including:

- federal agencies (for example, National Science Foundation, National Institutes of Health, Department of Defense, Department of Energy, US Department of Agriculture, and National Aeronautics and Space Administration),
- private foundations (for example, Beckman Foundation, Dreyfus Foundation, Sloan Foundation, and Welch Foundation - Texas only),
- professional societies (for example, American Chemical Society – Petroleum Research Fund, Texas Space Grant Consortium, Water Environment Research Foundation, American Heart Association, and American Cancer Society), and
- industry (for example, Microsoft or Honda).

Many university sponsored projects offices maintain comprehensive lists of available new investigator programs with active links^{1,2,3}. Overall the funding amounts vary by organization, but most federal new investigator awards are for 3-5 years funded at \$100-300K per year. This paper will focus on federal new investigator programs in general as they serve a broad audience

and are typically very competitive programs, and in particular on the largest of these awards, the NSF CAREER program⁴.

New investigator programs serve to identify and attract promising new investigators to the agency funding the program. These grants target new investigators with less research experience and fewer preliminary results, putting them at a disadvantage when competing for regular research grants. However, by restricting the competition to early career researchers, the playing field is leveled and the most promising new researchers can still be identified by the funding agency. Historically, these awards have been related to the number of years since Ph.D. graduation, but many programs now connect eligibility to tenure-track untenured assistant professor status and the number of submissions to the program, thus not eliminating from consideration those on a less traditional career path (for example, the NSF CAREER⁴ or the Defense Advanced Research Projects Agency (DARPA) Young Faculty Award⁵).

These kinds of programs are investing not only in the research proposed but also in the researcher and his or her career, and writing those proposals often requires a somewhat different approach compared to writing standard research proposals. In addition to focusing on the particular research project proposed, reviewers for these programs are looking for signs that the PI, if given the chance, will become one of the leaders in their field and will conduct important research in the funder's area of interest. Some agencies have additional criteria; for example, NSF encourages junior faculty to engage in innovative education and outreach activities that integrate with their research.

Notwithstanding these peculiarities, new investigator awards offer substantial benefits making them worthy of serious consideration by eligible faculty. Competitions are among peers and often require less preliminary data than other research proposals. By themselves most of these awards do not offer extraordinary amounts of funding, especially considering that they also require competitive teaching and education components, but they provide an avenue for new faculty to jump start a promising career with a long-term research plan and enough funding to leverage additional funding from other sources. Awards from these programs are prestigious, so the national recognition is significant for beginning independent researchers. A final advantage to competing for these awards is that they can have higher funding rates for new PIs than other research grants⁶. National Science Foundation data shows greater success by new investigators in the CAREER program than for other awards to new PIs for all NSF directorates except for the Social, Behavioral and Economic Sciences Directorate. For example, data presented at a 2008 NSF Regional Grants Conference, showed a 20% success rate for CAREER awards in the Computer and Information Science and Engineering Directorate (CSE), while new PIs in other CSE programs had only a 12% proposal success rate the same year; differences in success rates for other directorates were not a dramatic but still substantial.

Our Program Approach: Help for Administrators

As a help to administrators seeking to assist faculty in proposal development, specifically targeting junior faculty and new investigator programs, we offer our approach as one successful model. In the following paragraphs we detail our new faculty programs for administrators to consider implementing to aid faculty proposal development on their campuses.

Because the objective of new investigator programs is to identify and support researchers based not only on the proposed research project but also on their future promise as researchers, these proposals are different from pure research proposals (as described in detail above), often requiring significant education and teaching components and a long-term integrated career plan. These additional aspects prove difficult for some faculty, especially new investigators with little or no teaching experience and few on-campus contacts in these out-of-discipline areas for scientists and engineers. New faculty hires usually represent a significant investment of time and money by an institution in the form of recruiting efforts and start-up packages, so faculty success is important for an institution. To meet these needs, we have developed a program of opportunities for faculty to aid their proposal writing efforts, especially related to addressing new investigator awards.

Our ultimate goals are to help new faculty become successful and to bring more research funding to Texas A&M University, but this is not always a straightforward or easy process. It involves assessing faculty needs and providing an assortment of opportunities for them to interact with us and learn vital proposal development skills. Sometimes this is as simple as making faculty aware of new investigator opportunities available to them, but could be as involved as working one-on-one with the faculty member from program identification through final proposal submission. We provide opportunities for faculty to interact with our staff in times and ways that are beneficial to both us and them with respect to the limited time faculty have available and without our being continuously available to meet every schedule.

Most campuses have some proposal development resources, as a minimum an office or person in charge of sponsored programs is available. Following is a list of components comprising our approach to new faculty proposal development assistance. Some of these components require significant time and financial commitment by the institution, but some are much less intense and can be as simple as alerting faculty to resources already available on-line. Our program approach consists of the following integrated elements:

- *Staffed office for pre-proposal development support to faculty* – Our offices are dedicated to serving faculty in the proposal development and writing process, apart from budget preparation and boilerplate-type services. We work to train faculty to further develop the institutional infrastructure to support increased research capacity. Between our 2 offices we have 14 staff members, including research development specialists and other support staff, to support a campus of nearly 900 faculty in 12 different colleges and schools with over 70 departments and programs, so our support efforts must be focused to address the broad needs of faculty, but specific enough to be of value. The new faculty focus is one aspect of our offices missions, and the only one to be detailed here. Our purpose is to help faculty become better proposal writers, especially as they begin their academic careers. The main purpose of interaction with any faculty is to increase the competitiveness of their proposal efforts.
- *Resources on the web* – The first resource for faculty interaction with us are our web sites with lists of funding opportunities, extensive proposal writing tips, resources, and links, and federal agency proposal templates to begin the proposal process^{7,8}. Simply making faculty aware that applicable programs exist is often all they need. With regard to new investigator opportunities, some are very prestigious, highly competitive programs, but some are smaller niche specific

opportunities from foundations and professional societies for which most eligible faculty can be very competitive without significant help from us.

- *Seminar with panel* – We offer a seminar twice each year focusing on the NSF Faculty Early Career Development (CAREER) Program⁴. This targeted seminar also addresses general proposal writing and lists other new investigator programs available. The first offering of the seminar occurs in the Fall to inform and allow interested faculty to subsequently register for the semester-long grant writing workshop held during the Spring semester (see details in the next section). The second offering of the CAREER seminar, later in the academic year, targets the regional campuses within our system and is offered via videoconferencing technology. Overall seminar details include: (1) An introduction to NSF culture; (2) A description of the CAREER program and its elements; (3) Details on preparing a competitive CAREER proposal step-by-step; (4) Education plan and outreach resources; and (5) Panel of awardees and reviewers. The first two items are straightforward, presented to inform participating faculty of the program. The proposal preparation details are provided in the final section of this paper as a resource for faculty. On-campus education programs available for faculty to use and become part of are presented along with a presentation by a broader impacts representative. Panels include previously funded CAREER faculty, as well as former NSF reviewers.
- *Semester-long workshop* – This extended workshop concentrates on proposal development and writing skills, with each cohort serving as a reading group to assess each members proposal components as they are developed. This workshop is open to all faculty on a competitive basis, with a cohort of new investigators developing an NSF CAREER or other new investigator program proposal available. During this intensive workshop, participants are guided through the entire project development and proposal writing process. Specifically, participants engage in a one-on-one review of their project summary, in bi-weekly peer review meetings with three to four other workshop participants, and in additional meetings with all workshop participants. These activities give investigators the opportunity to obtain substantive feedback on their proposals and to acquire in-depth information on a range of proposal-related issues, such as analyzing the target funding agency’s mission, presenting project ideas to program managers, improving writing and formatting, developing evaluation and assessment components, and preparing budgets. By the conclusion of the workshop, investigators have prepared a complete grant application, which they may then submit to the external funding agency of their choice.
- *One-on-one consultation* – Separately from the semester-long workshop or the targeted seminar, we offer one-on-one consultations to faculty preparing proposals to submit to new investigator competitions. Proposal review includes feedback on overall approach strategy, content advice if possible, in-depth technical generalist review, and grammatical editing.

Feedback and evaluations of the seminars and workshops have been positive, a resource touted by faculty as very valuable. Moreover, the availability of this resource has been used by some Department Heads as a tool when recruiting new faculty. Overall successes include a general increasing trend in the number of CAREER awards to Texas A&M University over the time since these seminars began. The number of CAREER submissions through the Texas Engineering Experiment Station has also doubled in the last five years. The number of eligible faculty on campus has increased, so this is likely a factor in the overall trend, but during this same time funding rates at NSF have declined, so our actual success appears to have increased by even more than raw data show.

Proposal Development: Help for New Faculty

The first step for faculty is to identify new investigator programs for which they might apply. Lists of programs that fund early career investigators are published on the web by various university proposal development and sponsored projects offices, including ours^{1,2,3}. Additional help is available to help faculty locate the programs best for them with detailed advice on how to navigate grants resources⁹.

When evaluating whether to apply to a particular program for early-career researchers, the first step should be to check the eligibility rules. These vary significantly from program to program. Some programs fund only postdoctoral fellows, some fund only researchers in tenure-track positions, some fund researchers who earned their degrees within the last five years, and so on. Second, faculty should make sure they understand the funder's research interests. These may be very broad (for example, the Camille & Henry Dreyfus Foundation New Faculty Awards program funds new faculty in chemistry, biochemistry or chemical engineering) or quite narrow (for example, the Crohn's & Colitis Foundation of America Career Development Awards fund only research related to inflammatory bowel disease).

Even when research interests of an agency cover a broad range of fields, program directors and reviewers will tend to fund research in areas they view as dynamic and "leading edge". It is therefore important for PIs to make a strong case that their selected research area holds the potential for years of continued advancement and discovery. Research topics that have been well-researched and promise only incremental advancements are unlikely to help a new researcher to rise to the top of his or her field.

Although these programs are targeted specifically at "new" investigators, reviewers will still be looking for evidence that an applicant is likely to be successful, and an important part of that evidence will be previous publications and preliminary data related to the proposed research project. One exception, however, is the NIH Career transition award, which is specifically aimed at helping researchers transition from one field (e.g. clinical work or basic science research) to biomedical research. In that group of programs, one or more mentors must be named, and their track record and publications are extremely important in the review process.

The NSF CAREER

The largest single grant program specifically for junior faculty is the National Science Foundation's CAREER program, with over 400 grants awarded each year. This grant provides 5 years of funding (a minimum of \$500,000 total for proposals submitted to the Biology Directorate and a minimum of \$400,000 for all other proposals) to tenure-track, untenured faculty in an assistant professor or equivalent position. Faculty are allowed to apply for the grant up to three times, as long as they have not already won a CAREER award. Proposals are accepted annually and are usually due in mid-July. Links to the solicitation, an FAQ page and abstracts of previously awarded CAREER projects can be found at NSF's CAREER webpage⁴. The NSF also sponsors a competitive workshop annually for interested faculty¹⁰ and results from this workshop have been published as a resource for faculty writing a CAREER proposal¹¹. They also have sessions targeting the CAREER at their semi-annual regional grants workshop⁶. Other

organizations support national workshops on the CAREER program targeting their members (for example, the Quality Education for Minorities¹²) and ASEE has published in this area¹³.

PIs must submit CAREER grants to a particular directorate and program within NSF, based on the area of research addressed by the proposed project. Officially, NSF awards CAREER grants in any area of research that is normally supported by NSF, but in practice, some directorates fund more CAREER grants than others. The reason for this is that each directorate sets its own priorities, and some directorates place a strong emphasis on awarding CAREER grants to promising junior faculty, while others prefer to use unsolicited awards for that purpose. Also, some directorates have larger budgets than others and are therefore able to fund more CAREER grants. It is very important to make sure that a proposal is submitted to the NSF program that best fits the proposed research, because a good CAREER proposal submitted to the wrong program may be doomed. Contacting the Program Director is especially important for the CAREER, as a Program Director can give feedback on which NSF program best fits a PI's research, advice on points to emphasize and pitfalls to avoid, and the directorate's research priorities.

CAREER proposals require an Integrated Research and Education Plan to, in the words of NSF, "build a firm foundation for a lifetime of integrated contributions to research and education." This means that a CAREER proposal must not only have a research plan, but must also include an education plan integrated with the research. PIs often ask how important the education plan is. The answer supported by past NSF CAREER proposal reviewers¹⁴ is that because the CAREER program is highly competitive and many good proposals are submitted, both the research and the education plans must be excellent in order to win. That does not mean the education plan must be as extensive as the research plan, but just as the research plan will be judged based on how innovative, significant and well-thought-out it is, the education plan will be judged on the same criteria. Typically, out of a 15 page project description, around 3 pages will be devoted to the education, outreach and broader impacts components of the project. A conventional, unoriginal education plan is unlikely to excite reviewers and will put a proposal at a disadvantage. That said, it must be remembered that no matter how good the education plan is, no CAREER proposal will be funded unless it includes an excellent research plan.

The Research Plan

The research plan should address an area of interest to NSF, it should be innovative and exciting and should hold the promise for significant impact in the field. Research that promises only incremental progress on a well-established line of inquiry will not be competitive¹⁵. On the other hand, high risk projects with little preliminary data are unlikely to be funded because reviewers want to fund projects with a good probability of success. In developing a CAREER research plan, the PI must therefore balance innovation and impact against risk. Since the PIs track record is not as extensive as that of a senior researcher, a case must be made to the reviewers that the PI has the expertise and resources required to accomplish the proposed research.

There are several ways a PI can convince reviewers of his or her abilities: discussing prior work and publications, describing preliminary data, and documenting collaborations. Expectations vary depending on discipline, but it is usually important to propose research in an area where the

PI has publications, or, if the PI is moving into a new area, where the skills demonstrated in his or her published research will transfer well. Including preliminary results is also extremely important in many disciplines and can be used to bolster the PI's case that the proposed research is feasible and that they are capable of conducting the project. In addition, if there is a particular aspect to a research idea that reviewers may view as questionable or high risk, preliminary results may be a way to convince them that an approach is likely to be successful. Finally, if there is an aspect of the PI's research that is somewhat outside his expertise (an increasingly common occurrence as disciplinary lines are blurred in new areas of research), it may be a good idea to recruit a collaborator who can contribute that expertise. In CAREER grants, a co-PI cannot be included, but established researchers will often provide advice in the role of an off-budget collaborator. In that case, the PI should include in the Supplemental Documents section a letter from the collaborator specifically stating what the collaborator will do and the expertise he or she can provide.

When writing a CAREER research plan, the PI should answer the following questions in the first few paragraphs:

- What are the goals (the big questions the research will answer) and objectives (how the PI will answer them) of the research plan?
- How does this research support the career plan of research (the line of inquiry to pursue over the next 20 years)?
- Why is this research important?
- What general approach will be used? (This might be a methodology, a strategy or a list of the major tasks)
- How is this research plan innovative, novel and/or transformative? (How is what is proposed different from what's already being done by others, and why is it more likely to be successful?)

The sections of the research plan should follow the format of a research proposal, with background, preliminary results and methodology/experimental plan sections, but NSF allows flexibility in writing the project description, so it can be tailored to fit the proposed project. Some example outlines for CAREER proposals are available¹⁶. Since the grants are for 5 years, it is important to propose a research plan that will take about 5 years (while reviewers expect the scope of research plans to be ambitious, it is important to avoid being unrealistic). Usually, reviewers expect to see quite a lot of detail for the first year of a research plan and progressively less detail in later years. If there is a possible roadblock in the research plan (for example, obtaining negative results in the first year making it difficult to proceed with the plan as written), the proposal should include a discussion of how the PI would work around that. Reviewers will be hesitant to commit 5 years of funding for a project that could be derailed in the first or second year.

The Education Plan

Education plans typically include several activities, often aimed at different constituencies. Most CAREER education plans will include: activities to enhance undergraduate and graduate education, outreach to K-12 students or to the larger community, and at least one proposed activity addressing diversity. For example, a PI might plan to: 1) develop a new undergraduate

course utilizing inquiry-based learning techniques, incorporating the PIs research results; 2) act as a mentor for high school students developing science fair projects at a school with high minority enrollment; 3) host two undergraduate students from a predominantly undergraduate institution for summer research experiences using an NSF REU Supplement; and 4) develop and moderate an interdisciplinary journal club for graduate students interested in interdisciplinary topics related to the PI's research. Other examples of CAREER education and outreach activities are available^{17,18}.

Successful education plans propose activities going beyond what would be expected as a normal part of a faculty member's job but are not so ambitious as to impose an unreasonable burden on the PI who, after all, must still earn tenure. Connecting with existing infrastructure on the PI's campus, for example, an existing Research Experiences for Undergraduates program, or a science summer camp for middle schoolers, can allow significant impact without the logistics taking too much of the PI's time. However, making at least one of the activities unusual or innovative will help the education plan stand out against the competition.

In writing the education plan, the PI should state explicitly what the educational goals are and how the PI will assess whether those goals are being met. For example, if the PI will be mentoring undergraduates in a research experience, is the goal to encourage them to continue to graduate school? In that case, the assessment plan might include before and after surveys of their interest in graduate school as well as a plan to track whether they do, indeed, go to graduate school. Is the goal to improve their understanding of the research process or their understanding of certain scientific concepts in the discipline? In that case, the PI might plan to conduct before and after tests or interviews to assess if the students understanding of the research process or scientific concepts was enhanced, and so on.

Just as it is a good idea to include a discussion of prior work and preliminary results in the research plan, the PI should discuss previous activities engaged in related to the education plan. For example, if the PI plans to work with high school students and has done so in the past, describing that work will help to convince reviewers of her commitment and of the fact that she knows how to work with high school students. It is also important to include scholarly references related to education when discussing the approach. So, just as a researcher would cite articles to provide background for a research plan, he should cite, for example, articles on inquiry-based learning if he is proposing to develop a new course utilizing inquiry-based learning. An excellent resource for finding journal articles on a particular education-related topic is the Education Resources Information Center (ERIC)¹⁹.

And finally, the PI should work to integrate the education plan with the research plan. It is especially important to ensure that the education plan does not look like an "add-on." It is a good idea to state explicitly how the education and research plans are related. When giving the overview of project goals in the one-page Project Summary and in the first page of the Project Description, the PI should include the education goals along with the research goals. Some PIs even structure their Project Description to interweave the project plans for the research and education components together. Most PIs discuss the research and education plans in separate sections but describe them both in the early overview sections of the proposal.

While developing a CAREER proposal can seem daunting at first, junior faculty should remember that they have three tries to fine-tune the proposal, and reviewers try hard to give PIs helpful feedback so that they can improve their proposals for resubmission.

Conclusion

Providing training and resources for faculty who qualify for early career grants can encourage them to apply for these grants, help them prepare more competitive proposals, and help these faculty to develop their overall skills in writing grant proposals. The level of support can range from simply making faculty aware of the resources for information on writing these kinds of grants that are available on the web and in published papers to hosting workshops to providing one-on-one planning and editing support. At Texas A&M, we have found that providing this kind of support has provided not only near-term benefits in terms of grants awarded, but has also resulted in long-term benefits by helping to nurture the skills and careers of our junior faculty, and thereby raising the level of research of the entire institution.

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