

The National Science Foundation and Its Quest for Tomorrow's Academic Leaders

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Abstract—This paper presents the author's experience as a recipient of a Faculty Early Career Development (CAREER) Program Award from the National Science Foundation (NSF) and as a reviewer of several NSF proposals, including CAREER proposals. The paper also provides some ideas that, in the author's opinion, might be useful to a new faculty member who is planning to submit a CAREER proposal to the NSF. This paper is primarily intended for such faculty members, though some of the ideas contained here may be of value to anyone preparing an NSF proposal for the first time.

I. INTRODUCTION

It is the mission of the National Science Foundation (NSF) "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense..." [1]. An important part of this mission is to identify those members of the academic faculty who are committed to this research and development, and to education and outreach activities that will contribute to the advancement of science and engineering as well as to the development of a sound and knowledgeable workforce. This aspect of the NSF's is manifested in its Faculty Early Career Development Program, also known as the CAREER Program. While most will acknowledge that many faculty members who do not apply for or otherwise receive CAREER Awards become exemplary professors, Program Managers and members of panels reviewing CAREER proposals do make an honest attempt to identify those applicants to the Program who seem committed to the cause and appear the most likely to grow into "academic leaders of tomorrow."

I bring out the above observations because I feel it is important for an applicant to NSF's CAREER Program to bear this in mind while preparing her/his proposal. In the following sections, I will share some of my experiences as a recipient of an NSF CAREER Award, and as reviewer of several NSF proposals, including CAREER proposals. I will also share some thoughts and suggestions that, in my humble opinion, might be useful to a new faculty member who is planning to submit a CAREER proposal to the NSF.

In this paper, I provide a brief description of my experiences as an awardee and as a reviewer, and some recommendations based on these experiences. I then provide an overview of my own career proposal, with the hope that this will serve as a useful illustration.

II. EXPERIENCE OF AN AWARDEE

I submitted my CAREER proposal in July 2001, one year after I started my academic career, and the grant commenced in May 2002. Prior to this, I had received two small and two medium-sized industry grants, but it was the CAREER grant that enabled me to focus on building a coherent research, education and outreach program. It also helped me form valuable partnerships and collaborations, and I subsequently received two more industry grants and one more NSF grant to support research projects related to *microgrid architecture*, which was the topic of the research component of my CAREER proposal. The second NSF grant was in support of a collaborative research proposal.

III. EXPERIENCE OF A REVIEWER

I have served as a reviewer of several NSF proposals, including CAREER proposals. While I hope that the service I provided benefited the NSF, the experience certainly benefited me. I acquired an understanding of the objectives and the mechanism of the peer review process employed by the NSF. What was most valuable to me was that my first opportunity to serve as an NSF panelist preceded the preparation of my CAREER proposal, and I believe the review experience contributed significantly toward the success of my proposal. My later experiences as an NSF panelist further enhanced my understanding of the process, and I present in the next section some of the knowledge that I acquired from these experiences.

IV. CONSIDERATIONS IN PROPOSAL PREPARATION

The following tips are intended for a new faculty member who is planning to submit a CAREER proposal to the NSF; however, some of these suggestions may be of value to anyone preparing an NSF proposal for the first time.

A. General Tips for Proposal Preparation

- 1) Obtain from NSF examples of successful proposals. You can do this through the NSF web site [1].
- 2) Most Universities offer workshops on proposal preparation. The NSF, too, offers such workshops at several Universities.
- 3) If possible, visit with the NSF Program Manager in your field. Very often, she/he will provide valuable

information that will help you with the preparation of your proposal.

- 4) If possible, find a way to participate on a NSF review panel before you write your NSF proposal. As I stated above, I was able to participate on a panel prior to preparing my CAREER proposal, and the experience benefited me significantly. Talk to your mentor, department chair/head, or other senior faculty to see if anyone can open a door to such an opportunity.
- 5) In my opinion, the significant contribution of your proposal needs to be brought out in the first 2-3 pages. Elaborate later, but the first two pages must give the reviewer a good reason to continue to read the rest of the proposal seriously.
- 6) An important consideration to reviewers is: "Can this be done, and can this PI do this, given his/her experience and the resources available to him/her?" In my proposals, I made repeated attempts to link the proposed work to my past work, cite my own publications, and establish my credibility.
- 7) Never pass up an opportunity to bring out the significance of your work. It is acceptable to repeat yourself, provided you do not do it too often.
- 8) Be aware of the kind of budgetary limits that apply to the solicitation to which you are responding. Most solicitations clearly mention prevailing funding amounts. For unsolicited proposals, discuss funding amounts with your program manager. It is a good idea to keep your budget approximately within applicable limits, and plan the scope of the proposed work accordingly.
- 9) Follow all instructions to the letter, and adhere to the recommended format. This is very important, since I have seen reviewers getting upset about PIs not following instructions.
- 10) Get a mentor, a colleague, or your doctoral advisor (or all of the above) to review your proposal before you submit it.

B. Specific Tips for Preparation of a CAREER Proposal

- 1) The first thing to do is to download from NSF's web site [1] the most current versions of the *Grant Proposal Guide* and the CAREER solicitation, and familiarize yourself with the rules and requirements.
- 2) Some Universities offer workshops for those faculty who plan to submit CAREER proposals. Find out if your institution does this. If not, inquire into the possibility of attending a web-cast from a University that does. There are Universities that make their workshops accessible via web-casts.
- 3) Make as many attempts as you can, and make every attempt count. First, understand the eligibility criteria. These change from time to time. For instance, at the time when I applied, one could apply up to four times, but all attempts had to be within eight years of receiving the Ph.D. Now the second restriction has been removed, but the number of attempts has been reduced to three.

Plan so that you can take all three attempts if necessary. If you do need to make a second or third attempt, make sure you incorporate, as far as possible, all the suggestions from the reviewers. The NSF expects reviewers to provide useful and constructive feedback to proposers, and in most cases reviewers make every effort to do so.

- 4) Do not rush into submitting your proposal. Plan ahead and take as much time as you can, paying attention to the constraints—you should be able to make all the attempts you are allowed, yet you have to make them all before you get promoted to Associate Professor.
- 5) While you prepare yourself for your first attempt, get other grants if you can, but most importantly perform some amount of research that will increase your credibility.
- 6) Although your proposal will be evaluated on the basis of your research plan, it is essential to integrate it well with your education plan. Try to be creative with your education and outreach plans as well. Do not convey the impression that you regard the education component as a mere formality. Similarly, do not neglect the "broader impact" component. If you do not understand this very well, seek advice from your department and college leadership.

V. MOTIVATION AND OVERVIEW OF MITRA'S CAREER PROPOSAL

A. Background and Motivation

Before submitting my CAREER proposal, I had collaborated with a senior colleague and obtained a couple of industry grants, one of which concerned distributed generation (DG). I had realized that this was a fertile area that afforded considerable opportunity for exciting and cross-cutting research. I had also become aware of the US Department of Energy's vision of microgrids and its plans for increasing penetration of distributed energy resources. I knew I wanted to work in this field, and to apply my expertise in power system reliability to my work. I asked myself the following question: *If I could envision what microgrids would look like two decades hence, what tools could I develop that might hasten the systematic transformation of present day distribution systems to microgrids of the future?*

I decided that I wanted to work on *reliability-driven architecture of microgrids*. I felt that of all the benefits of microgrids, reliability was arguably one of the most compelling. It is a major consideration in cases where the cost per kW is an issue. Moreover, the ability to install DG at or near load points immediately opens up the opportunity to offer reliability-differentiated services. These considerations motivated me to propose to develop methodologies for reliability-centered design and planning of systems where distributed energy resources could be deployed.

I also felt strongly about how in recent years (a) enrollment in power and energy systems programs had declined, and (b) salaries of power engineers had declined, in spite of a growing trend in global energy needs. I wanted to engage in education

and outreach activities that would have some positive outcome, no matter how small, in addressing at least the first of these problems. My CAREER proposal gave me the opportunity to express my desire to engage in such activity.

B. Overview of Proposal

I provide here an overview of my proposal, and a description of how I organized it.

The scope of my proposed work consisted of the following.

- Evaluate the impact of recent developments on reliability analysis methods.
- Enumerate and analyze possible microgrid architectures and develop appropriate reliability techniques.
- Develop suitable methods for integrating analysis techniques for overall reliability assessment of interconnected systems.
- Demonstrate the developed methods by implementation of research grade computer programs.
- Modernize the power systems curriculum to include recent developments, as well as introduce two new courses of contemporary significance.
- Integrate some of my research in the courses that I would teach.

In the first two pages of my project description, I provided a summary of the work plan, and brought out the significance of the proposed work. I then proceeded to provide detailed descriptions of my research, education and outreach plans, and then provided a note on how my experiences had prepared and positioned me to perform the proposed work.

The description of the research plan consisted of the following.

- 1) An introduction to and the significance of the role of reliability in present and future power systems.
- 2) State of the art in power system reliability assessment. Here I provided brief descriptions of all existing methods, and also mentioned the contributions that I had made through my doctoral research. The latter was intended to establish my credibility in my field.
- 3) Research strategy and task definition. Here I provided detailed explanations of all the tasks, and their importance. For instance, I enumerated recent developments in the industry, such as the new structure, new operating policies, new approach to reliability, new technologies, and described how I would analyze their impact on models and architectures of distributed resources and microgrids.
- 4) Microgrid architectures and their reliability. This would comprise the core of my proposed work. I introduced the concept of microgrids, and the role of reliability. I described how I would develop reliability models of distributed resources, suitable methods for reliability evaluation of microgrids, and a methodology for reliability-oriented microgrid architecture. I described how closely cost is tied to reliability and how it would be included in the methodology.

- 5) Integration of models and methods; demonstration. I described how I would approach the integration of the models and methods, implement them in the form of research grade software and demonstrate them on suitable systems.

I then provided a work schedule for the research plan, and concluded the research plan with a statement on how I felt the research would impact the industry.

The description of the education plan consisted of the following.

- 1) An introduction to the Electrical Engineering Department where I worked and to the power engineering faculty, and a description of the power engineering curriculum.
- 2) A description of how I would modernize specific courses and of the new courses I would introduce. I also described the implementation schedule, i.e., the time frame in which I would offer the modernized and new courses. I concluded this description with a statement of anticipated impact.
- 3) Student and program development plan. Here I described how many graduate and undergraduate students I proposed to supervise, and in what sequence and time frames they would ‘flow through’ the system over the life of the award. I mentioned how two of the students had already started working on related research, supported by my prior grants.

In the the context of supporting students I would like to offer the following advice. The budget should include support for graduate students, but not undergraduate students. If you propose to work with undergraduate students as well, you should support them through a supplementary Research Experiences for Undergraduates (REU) grant from the NSF. If you plan to do this, it is appropriate to say so your proposal.

I provided a description of the outreach activities in which I was currently engaged, and other activities in which I planned to engage.

The final section of my proposal was titled, “Unique Position of the PI to Perform Proposed Work.” The purpose of this section was to reiterate my credibility in the field. I mentioned my contributions, during my doctoral studies, to the field of reliability evaluation. I mentioned my prior grant in the area of distributed resources. I mentioned my experience as a consultant, when I had worked in the area of industry deregulation. I mentioned my experience with collaborative research. I also mentioned the teaching award that I received as a graduate student, to show that I was also a committed educator.

VI. POST-AWARD WORK AND FOLLOW-UP FUNDING

It is relevant to provide a few comments on the work that I performed after I received the CAREER award. I was successful in completing most of the research that I had proposed in my research plan. Most of my work on microgrid architecture has been reported in [2] – [8]. Other work has also

been reported in various publications. One of the advantages of an NSF grant is that it affords considerable freedom in terms of the discoveries and innovations that you may perform in areas related to your proposal. I took advantage of this, and while developing methods for microgrid architecture using evolutionary computation techniques, I performed some additional research on application of these techniques in reliability analysis.

I also received two grants from Sandia National Laboratories to conduct research on related problems in microgrid architecture. Most recently, a colleague and I received another grant from the NSF to support research on autonomous operation of microgrids.

On the education front, I have successfully implemented all the work related to curriculum development, except for offering one of the proposed new courses. This was because I changed Universities, and at my new workplace this course is offered by a colleague.

I have supported two Doctoral and four Masters students out of my CAREER grant. I have supported other students, including two undergraduate students, through other grants.

I have also engaged in several outreach activities, including leadership in an industry partnership program, leadership in IEEE subcommittees, and organizing two symposia and several student activities.

VII. CONCLUDING REMARKS

Receiving my CAREER award has played a significant role in my establishing myself as an academic. I was a motivated academic right from the time I started my career in academia, but the CAREER award provided a significant boost to my growth and opened several doors.

If you are a new faculty member who is planning to write a CAREER proposal, I encourage you to invest as much effort as you can afford on preparing yourself prior to writing the proposal. There are ample resources that offer advice on grantsmanship, both in your library and on the internet. Reference [9] is one such example. As time allows, supplement the advice you get from workshops with such readings.

I think it is important to bear in mind that this is all about becoming an academic leader. Reference [10] offers excellent advice on getting a good start on your academic career.

I wish you success in all your academic endeavors!

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BIOGRAPHY

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