Working with NSF: Some Tips for Junior Faculty

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The pitch on my current research agenda was generating little interest with a newly found engineering colleague at the conference luncheon. Then I happened to mention how my research plans are connected to my former role as a *Program Manager* (PM) at NSF. The mere mention of NSF around academics can be enough to abruptly change the conversation, and this remark quickly got attention of faculty even at the table's far end. Realizing this, I readied myself for the inevitable onslaught of questions about NSF. And so they came.

This should be of no surprise. In 2018 approximately 83% of all federal funding for Computer Science R&D came from NSF and DoD [1]. As the primary source of basic research funding agency capital to make your department function, how NSF is thinking and acting on its mission is of considerable importance to both junior and senior faculty. And to Deans and VPs for Research too.

Yet it is possible this single funding statistic underestimates the importance of the Foundation, which is hugely influential in steering science research and education matters big and small. Learning about NSF, grants, proposal merit review, and how to engage the funding system successfully over your career takes considerable time and continuing effort. It is worth it. You – as either a prospective or junior faculty member -- are climbing the steep part of this learning curve, so I'll focus on you and your most common questions here.

The Black Box

I have been asked, and striven to answer, a wide range of questions about NSF from new faculty. As a former member of an institution committed to serving the academic research community, I was -- and still am -- happy to do so. In my experience all my NSF colleagues were too. But even if NSF seems something of an impenetrable black box to you now, you no doubt already have some understanding of the place and its people. You are aware that it is a federal agency, but perhaps you are unclear about its connection to other government entities. NSF's relationship with your university might also be seen as mysterious and largely bureaucratic in nature. Somewhat overworked and grumpy people are known to work there, perhaps including a number of esteemed if intimidating leaders in your own field.

But now you are faced with figuring your relationship to it for yourself. It would be nice if I could point you to web site and send you on your way. Sorry, but it's not that easy. The information you need will also evolve over time. For now, I can tell you something about getting started. But wait! I already have. Find a conference lunch table, seek out program managers, and just keep asking questions.

Let me confess that I claim no particular insight or authority to answer many of your questions. Most of what I write are my opinions, informed by some experience gained by participating in the proposal merit review process while immersed in NSF culture. So what is this culture? Like all large institutions, many NSF practices are local, and thinking and actions associated with funding research proposals evolves with transition of staff. The Foundation is a unique mix of public servants, itinerant academics, policy makers, deep domain science experts, and professional staff with expertise in grants and contract vehicles. No one person can easily explain all these moving parts, just as you are unlikely to be able to articulate the entire operations and culture of your university or college. But it will help you navigate the system by having a broad understanding of the relatively slowly evolving way NSF does its business.

One aspect doesn't change. NSF is a hub for the science and engineering community. Academic research ideas pour in in the form of pitches, grant proposals, visioning workshops, plans for scientific instruments, etc. All are reasons to stay in touch with PMs over your career, whether you are actively seeking funding or not.

PMs are the NSF staff members you will engage on most science matters, and they are the right level to get most of your questions answered. They create specific funding opportunities and read your proposals. For the most part, each PM has been where you are now. They are generally willing to provide disproportionate time and energy to assisting and mentoring early career faculty. In this group I include prospective, recently-hired and junior research and teaching faculty members who have not yet landed an award or two. Take advantage of their willingness to help. PMs want to help you climb the curve, in part because they, the Foundation, the research community, and the nation need you to succeed, and the alternative uses their time and taxpayer dollars poorly.

Getting Started

So, let's begin at the beginning. How much do you know about NSF, and the business of writing grant proposals? To find out try to answer these 3 questions:

> 1. What is the name (or acronym) of the NSF Division that will likely be the receiving organization for your next proposal, and who have you met who works there?
>
> 2. You plan to offer a short summer course informed by your research to middle school students in a town near your institution. Terrific! In what section of a proposal would you describe this effort?

3. What is the name of the grants manager handling proposals for your department, and how long before a proposal submission deadline should you begin to discuss your intent to submit?

If you have been submitting proposals for a year or more you might know the answers to these mundane administrative and process related questions. But you might not know the answers now; if so, this quiz should serve as a prompt to familiarize yourself with the pre-proposal submission processes at your institution. The good news is that these processes change slowly from year-to-year, and your institution likely has considerable machinery, experience and incentive to help you learn the basic mechanics.

Now the NSF side. Experience suggests that just about the last thing many new professors want to do is pick up the phone and pitch an idea to a PM. Or seek them out at a conference just to introduce themselves. After all, why -- after teaching and researching for the better part of a career -- would these folks be interested in hearing from a new professor? Well, first of all – it is their job!

But your own work just begins there. After an introduction and perhaps a pitch on your research plans you must do exactly this: immediately and repeatedly volunteer to visit the black box and work alongside these grumpy people who you believe have no time for you. And yes, you and many of your peers might also find this move to be mildly terrifying, and yet somehow the obvious thing to do.

And that is the central takeaway of this note: to encourage you to do that – seek out PMs, pitch your ideas, and do the community work. In fact, you must **_insist_** on it, because your career advancement is potentially at stake.

Consider the alternative. You will try to learn by reading solicitations (i.e., calls for research grant proposals) in stilted language that will be long on submission requirements and the dry scope of the research topic of interest, and short on the passions and opportunities seen by its authors. You will ask questions of your colleagues, who themselves have a limited perspective, and who often aren't well positioned to connect your research thinking to an available funding opportunity. Perhaps you will then seek to learn the contours of the black box by repeated probes in the form of proposal submissions thrown blindly over the wall. I suppose these approaches can and do work for some, but continuous direct personal engagement is strongly preferred. After all, this is why your research community has conferences that you elect to attend in person rather than experience through published proceedings. The business of your own research work and that of your peers is a human-centered activity. People are at the heart of advancing science - so get to know them and how they think. And let them learn about you and what you think.

Before we go further let's dispense with imposturism, please. If you are even thinking about writing a proposal to NSF, you have already been a huge success by many measures. By continuing to work with your customary diligence and persistence, you are only a few years away from a CV with an enviable list of research funding awards. Of course, it is unlikely you will hear this from your new department chair, even if she hired you quietly confident of this outcome. Nonetheless, believe it.

Still, you must learn some basics. Let's get started with a few.

Grant Proposal

Your proposed research project plan and an associated funding request. You have a fixed number of pages (e.g., 15) to explain 1) what you expect to accomplish; 2) how you will do it and why your approach will (or could) work; 3) the state-of-the-art; 4) how you will decompose your work into manageable tasks/subtasks (aka research thrusts, phases, etc); 5) who will be impacted by your work; and 6) an execution timetable.

Ideally, you will include evidence of some modest amount of preliminary work to convince the reader that you understand the problem, have thought or worked through basics, and have some plausible approach to address the tasks. A proposal is not a research paper. Do not leave the reader with the impression that the work is done, or that you have worked through more than a small part of your proposed plans. If you recently published a related paper, assume the proposal reviewers will be aware, and will expect to see a (brief) discussion of the relationship between the completed and proposed work.

It hardly needs to be said that the quality of the science proposed in the investigation needs to be strong. Beyond this, clarity of exposition is key to a good reception by reviewers. You will often hear the refrain which I paraphrase as "A well written proposal provides you an unfair advantage." Have writing skill or have writing help, but work hard to submit a well-written, understandable proposal.

Reviewers of your proposal start on your side by believing you have something important to say hiding under a possibly mediocre or unclear presentation, and they will spend considerable time deciphering your convoluted presentation. But they don't like doing this, or debating what they think you meant. Ask colleagues to read your draft submission and comment, and specifically call out its weakest parts.

Your research proposal is an expression of your finest ideas. You should aspire to excellence. But not every proposal you write will be

a masterpiece. You might, for example, be seeking to continue a funded but unexhausted research investigation for an additional period. In this case it is important to justify why continuing to pursue newly exposed areas within the topic is worthwhile. The fact that the earlier investigation was funded (or you wrote a dissertation on the topic) is inadequate in itself. Consider that your proposal will like be judged against another proposal describing a shiny, new research topic.

Start with a superb project summary - spend disproportionate time here. Make the reader want to read on to how you will achieve the outcome you describe up front.

What makes a proposal outstanding? I certainly don't know, and there is clearly no recipe. But an outstanding proposal is easily identified by the response it generates – it deeply engages its audience. As a reviewer you are absorbed, perhaps to the point you go off and begin reading cited work. A panel (see Panels below) discussion tends to shoot past the proposal itself and discuss the implications of a successful investigation. Collective audience **engagement** is a measure of an outstanding idea. Sometimes (not always) the basis of the engagement is the presentation of a key insight that is both unknown and disruptive by revelation. If possible, teach your proposal readers something they don't already know.

Now some good news. You don't have to write an outstanding proposal. Strive to. But you don't have to scale that bar to be worthy of funding. However you must write a proposal that is **unobjectionable**. It is interesting that many objections raised by reviewers are not quibbles about details buried deep in the proposal body. Rather, they can be failure to mention (and deflect concern about) limitations associated with your proposed approach or solution (e.g., will cost too much, risks a privacy invasion, only works for a certain class of data). After your summary, your next focus is to identify and resolve the weaknesses or potential objections your manuscript draft readers have identified. Consider what is missing and/or out-of-scope, and explain.

After you submit a proposal you can't discuss it with NSF. Except in exceptional circumstances avoid inquiring about a proposal's status or outcome. Just wait it out, even if this means July or August for a proposal you submitted late in the previous calendar year.

One additional note on proposals. You will write a variety of different types of non-research oriented proposals during your career (e.g., equipment requests, workshop proposals, teaching support requests). Your community likely has a template for each of these. When you are tasked with writing such a proposal, use your research community network to obtain a starter template to inform your submission.

Solicitations

You will almost always submit your work to a target call or solicitation. Your job is to identify the appropriate one. This is not as easy as you might think, particularly for inter- and trans-disciplinary work. There might be several potential funding opportunities for your research work; what you elect to propose, methods you use, and your chances of receiving an award all will reflect alignment with the solicitation. Solicitations tend to be broad in scope and do not necessarily reflect narrower areas that a PM finds particularly worthy or promising. Teasing out this subtext will be a key reason for continual engagement with PMs over your career.

If a PM suggests some *other* solicitation that might align with your research plans, get a name of an associated PM – usually the lead or cognizant PM, and follow up with that person.

Deeply consider the audience for your proposal; a PM is only part of the audience (see *Panels* below). When you write, know both your audience and the scope of the governing solicitation.

Proposal Placement and Re-assignment

Your submitted proposal arrives to NSF with many others targeting the same solicitation. PMs will meet to bin similar topic areas into bundles that can be reviewed together. Through your efforts in making yourself and your research plans known to PMs, with modest effort they will quickly recognize an appropriate bin for your proposal. Should a PM receiving your proposal believe that its aligns better with some other solicitation, the PM will strive to redirect it. This action will be taken in your best interest. You might be informed of this placement, but can't influence it (see *Declines and Withdraws* below). Avoid the need for this exception handling through advance communication with the PM. If a re-placement happens, accept the possibility that you have erred by inadequately preparing NSF to receive your work.

Rules

There are a lot of them [2]. Acronyms too. Like *RWR*. Failure to follow certain rules can get your proposal <u>Returned</u> <u>Without</u> <u>Review</u>. No professor has time for that, so learn and follow the rules. Your department grants official or university *Sponsored Research Office* can help enormously with proposal and award mechanics. Seek their assistance. Take any classes offered to new faculty. Examine all online resources for preparing grant proposals [3]. NSF receives far

too many proposals to be welcoming of non-compliant submissions, particularly those that might appear to provide the proposal an advantage over compliant submissions.

Broader Impacts

You are required to have a proposal section that discusses the Broader Impacts (BI) of your work. This section describes the potential educational, commercial, and societal benefits of your proposed research. Your section should explain how your work can potentially affect the world outside your narrow research community.

An outstanding BI statement demands creativity and personal engagement. Almost no rules restrict what work you propose to do. There is no requirement that you focus on impacts that align to some widely accepted social good, though it is perfectly acceptable to do so. I suggest you reflect on your interests and passions. Perhaps you will argue that your research on inertial measurement units will help future skateboarders on campus avoid injuries. Given that premise, one can easily imagine a plan of engaging with a college skateboarding club or teaching middle schoolers about gyroscopes through instrumented longboards.

Things not to focus on include describing work that is ordinary and expected in your current job, such as teaching and mentoring. Your BI plan should discuss forward-looking activities directly related to the research area. Evidence of prior BI projects with vague commitments about continuing with similar activities is thought inadequate.

How to get ideas? Think about partners you already engage. Reading other plans as a reviewer or panelist is also a good idea. Work with what you have; identify whether your university already enrolls a possibly underserved group of students, and craft a set of actions with that group in mind.

Not all BI plans are notable. Excellent plans tend to jump off the page and delight reviewers with an authentic sense of creativity, passion, personal interest, or desire to help a group. An excellent BI statement will not win an award if unaccompanied by outstanding research plans. But a novel description of broader impacts has the additional benefit of distinguishing your proposal from the pack.

Mathematics

It is difficult to generalize on the appropriate amount of proposal space consumed by mathematics. A proposal is not a research paper. Use enough to demonstrate what tools will inform your research, and

your familiarity with them. Appendices are for more; use one if you must, but sparingly.

The possibility of including an appendix brings up one additional small point. The length of your proposal description matters – use all the space available to you. Reviewers will object if you don't. Fair or not, failure to fill the allotment will be associated with almost any proposal weakness, as if the `missing' content would have resolved any issues or questions. Why bring this trivial observation up at all? Because it is a mistake you will never make if you witness a short proposal bashing in a panel.

Panels

After proposals are binned a proposal merit review panel is scheduled by a PM. The panel is the apogee of the entire merit review process. The PM selects a suite of volunteers from the research community who are well-suited to review (a subset of) the batch, and subsequently convene at NSF to discuss their review findings. In an effort to ensure independent analysis, panelists generally don't know what colleagues will also be participating until they enter the panel meeting room.

Who is well-suited to review your work? In general a panel comprises a mix of experts in your proposal topic (e.g., authors you cite in your work) and generalists active in related research areas. Your job is to write a proposal that has both depth to appeal to experts, and explanatory power and a convincing execution approach to appeal to non-experts. How to do this? By asking both types of colleagues to read your draft proposal critically.

Each panel is a unique manifestation of the research community doing its work of sorting out what research ideas are worth doing, and what are not. Yet a typical panel reflects the collective thinking not just of the attendees, but the entire research community. At one moment a panel can be mindnumbingly dull, as when there is a rapid consensus that a proposal is unworthy of funding. But the next proposal discussion can trigger a spirited debate between leading members in the field who strongly disagree[1] about the merit of an entire topic area or investigative approach – perhaps all triggered by your proposal. Why would anyone not jump at the chance to witness this or participate? Participate you must. You will be exposed to new ideas being considered by your research community, and you will benefit from learning what other panelists find *objectionable* in a proposal.

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1   There is a subtle distinction between *controversial* (often good, sometimes exceptionally important) and *objectionable* (never good).

You might be skeptical that proposals from a relatively unknown junior faculty member and a distinguished leader in the field will be treated similarly. If so, you would be wrong. What you write down in your 15 page project description is what matters. Yes, the process is single-blind (i.e.,the reviewers know the proposal investigators, and they know the leaders in their field). But panelists were junior researchers too, and they are committed to advancing the field by embracing the best proposal presented. Plus, one or more PMs are attending and weighing arguments made throughout the panel discussion, alert to panel dynamics and the many biases that can emerge in such a setting.

After the review process is complete (e.g., after a proposal is panelled), a PM puts together a case for Recommending your proposal to the PM's Division Director (see *People at NSF and their Roles* below). If awarded, a PM 'holds your jacket', an archaic reference to paper files that alludes to their oversight responsibility for your project for its duration.

People at NSF and their Roles

- Program Manager

  Best thought of as the person who will receive, read and walk your proposal through the merit review process. Often they are the sole author or co-author of the solicitation.

- NSF Support Staff

  The primarily civil servants who handle the administration of your proposal from its receipt to the completion of your project. If you receive an email on any matter from a staff member, respond ASAP.

- Leadership: Division Director & Assistant Director

  A Division Director (DD) oversees an organization of PMs, subject matter experts and support staff. From your position, a DD represents a check on a PM Award or Decline recommendation for your proposal, and an assurance check on the quality and integrity of the review process. If satisfied, a DD concurs with a PM's award/decline recommendation.

  An Assistant Director (AD) is the NSF point person for all matters for the entire science discipline (e.g., Biology Directorate). Busy conceiving and overseeing some of the most important initiatives in your field, this individual has effectively **NO** direct role in handling your proposal.

Should you have the opportunity to meet an AD or DD, a particularly easy way to strike up a conversation is to introduce yourself and ask who she knows in your department or university. As a conversation starter this is a sure thing, and in some cases you might find she knows some people in your department better than you.

Declines & Withdraws

It probably won't help if I tell you not to take personally receiving a Decline on a submitted proposal. I know this because senior investigators seem to be able to recall the name of the PM who issued their first award or decline recommendation, even several decades later.

A Decline is further aggravated when reviews you receive are puzzling, contradictory, obtuse, unhelpful, poorly written or incomplete. To make matter worse, reviewers and panelists can't be relied upon to be all that gentle in providing feedback[2]. Take some comfort that many of the leaders in your field who you seek to emulate are suffering the same frustration, sometimes on the very same day.

What you can do next is wait a comfortable period and schedule an appointment for a phone call with the PM at a time comfortably after the decision is conveyed (and well outside of their busy annual close-out period from mid-June to mid-August). A few general, neutral questions such as 'What did the panel believe was the primary weakness of the proposal?' is usually enough to get information that might be valuable toward a revision. Note that the PM -- who typically takes a look at the reviews before your conversation to recall the panel discussion and their own opinion -- is well aware of the entire context (see *Information Asymmetry* below) and lifecycle of the proposal. Directly challenging his (or any reviewer's) understanding of your work is often inadvisable.

If your proposal received a rating of *Competitive* (or equivalent), you should be strongly biased toward resubmitting in the following funding cycle, if that option exists. If you received a *Low Competitive* (or equivalent), you should also be biased toward resubmitting, but only after substantial revisions. In any case, it should be obvious to the PM that your revision sought to address all concerns identified in the reviews and panel summary you received.

For some time after you submit a proposal (but prior to its review) you will have the option of withdrawal. Electing to take this action is uncommon, but is worthwhile in rare circumstances (e.g., the

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2. There is some evidence that the CISE Directorate is the worst offender in damning feedback [4].

mechanics of a proposal submission failed in some way). There is no penalty associated with a withdrawal. If a PM suggests for any (or no) reason that a proposal be withdrawn, I would encourage you to follow their advice (see *Information Asymmetry* below).

Complaints, Criticisms, Appeals, and Letters of Support

The calculus of limited award funds means that many of your submitted proposals will be declined. One course of action is to respond emotionally and seek to complain.

Erase this course of action from your mind. It simply won't work. Nor will any other method of supporting or appealing the outcome of an individual proposal decision. Your chair, dean, or congressperson can't help here. For NSF the integrity of the merit review process is an existential matter, and external influencers are heard, acknowledged and politely ignored.

Swinging for the Fence

Don't. Your first proposal almost certainly shouldn't be a LARGE, or a CAREER. A little humility helps when working against an acceptance rate that could be well under 20%. When getting started consider **collaborating** with a more experienced colleague (from anywhere). As you will discover NSF moves deliberately. A preferred approach is to get on the board with some small wins; this allows you to learn the process, become known to PMs, and demonstrate your ability to deliver on larger and more substantive projects later. Should you choose to submit, your CAREER proposal will come from a recognizable research community participant with an established track record.

Questions Not Asked

A controversial topic: I'm at something of a loss to understand why I have never been asked any variant of the straight up question "What is the easiest way to obtain award funds?" The question's crassness seems to undercut the higher level purpose of scientific research, and I imagine it would not be well received by some PMs. For such a question to be worthy of a response it would likely only arise in the context of a larger discussion about research goals, award history, and other background.

But I wouldn't find this question out of turn from a junior faculty member who has had little or no mentoring or early fundraising success. I would rather a scholar ask this question than leave the conversation without new and constructive ideas on moving forward. So

in some one-on-one conversations I simply ask and answer this question for them. Sometimes this reveals some basic missing knowledge, such as the value of a receiving a small equipment award to supplement a new-hire startup package in initiating a laboratory or student team.

Getting an initial award and advancing to the status of Principal Investigator is an important career step. Best to not delay this by not asking for help, or waiting for a more scholarly contribution to be recognized and rewarded.

Information Asymmetry

Obtaining grant funding is hard work. In the process, lots of things seem to go wrong. If you are a .300 hitter, you are a superstar.

Many, many researchers find the entire process time-consuming and extraordinarily frustrating. You might find that you submit 2 proposals, and somehow what you believe is the least strong of the 2 gets funded. Or you sit on a panel that ranks a proposal highly, and to your surprise the proposal is ultimately not funded. What's going on?

I have sat at many conference lunch tables where sentiments are expressed suggesting that the selection process is seemingly arbitrary, random, or even favoring some other party. I offer a much simpler suggestion. Whatever your perch, you are one participant in a multi-round decision process where you have limited visibility. The award selection process isn't and can't be fully transparent. Simply put, a decision to make an award encompasses far more information than is available to any PI or panelist. It is not at all surprising that an outcome seems at odds with the most likely one as seen from your perspective.

Final Remarks

You might have noticed that I haven't written all that much about how to write a successful proposal. Instead, I have told you *how to learn* by 1) being assertive and reaching out to PMs to introduce yourself and pitch your research ideas, and 2) persistently volunteering to participate in a merit review panel. To learn, take what is offered, even if it means a panel reviewing proposals in an area of only modest interest to you.

You might have noted that I have not used adjectives such as `fast', or `efficient' to describe any NSF process. Though many processes are imperfect, I have found that the results tend towards `eventual correctness'. I trust that the research community sees it this way as well.

I hope that you take these notes in the spirit intended – to advantage you in your pursuit of sponsored research funding. It is a long slog, and it never lets up. If you've read this far I am confident you are willing to learn and succeed. Let me assure you that by engaging in the process with your accustomed thoughtfulness and effort, you will succeed in establishing an enviable funding record over time.

Good luck!

References

[1] National Science Board S&E Indicators 2018. Also see

National Science Foundation, National Center for Science and Engineering Statistics, Survey of Federal Funds for Research and Development, Fiscal Years 2017-18.

[2] Proposal & Award Policies & Procedures Guide (PAPPG).

[3] Computer Science: Research Grants & Funding Resources, UC Irvine Libraries. (Note: UCI access only, but illustrative of public resources).

[4] Jeannette M. Wing, "Yes, Computer Scientists Are Hypercritical", BLOG@CACM, Communications of the ACM, October 6, 2011.