

Advice on Writing Proposals to the National Science Foundation

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What follows is a collection of advice for writing research grants to the National Science Foundation. It includes some guidelines on how to write an NSF proposal and how to get the latest version of the NSF forms. There are some NSF forms, such as the Disclosure of Lobbying Activities, that your grants office will provide for you.

This document focuses on writing proposals to NSF, but the following general advice can be applied to writing any proposal.

General advice

Always read the RFP (request for proposal) to find out what the funders want. They will give you money only if you can help them reach their goals. The goals of funding agencies (public and private) vary dramatically. A successful proposal to NSF looks nothing like a successful proposal to NASA. Even within an agency, the style of proposals can be different among internal divisions. Find out about the agency, its goals, and its review system.

All proposals should answer the following questions in one form or another.

- What is the problem being addressed? (What is the goal of the research being proposed? What is the hypothesis being tested?)
- Why is the problem important and interesting?
- What will you DO to address the problem? If you complete the plan, will that bring us closer to an answer to the problem?
- Do you have the resources (equipment, grad students, access to industry ...) necessary to complete the research?

Writing NSF proposals

NSF is organized a lot like a university, except that instead of departments and colleges it has divisions and directorates. The program directors are like professors (and a lot of them are professors on leaves of absence). They have areas of specialization which correspond to the research areas covered by their programs. The division directors are like department chairs. They oversee the broad research areas covered by the programs and deal with administrative issues. The Assistant Directors are like Deans of Colleges. They lead the directorates and are responsible for the major research directions in Engineering, Physical Sciences, etc. The Director of NSF is responsible for the overall direction of Science and Engineering Research. However, unlike a university, NSF

reorganizes constantly. This means that you may get to know a program director who may suddenly return to his or her university or may be reassigned to another program -- or that your program may be merged with a different program. While this is disconcerting in the short run, in the long run it keeps programs from stagnating and helps NSF keep on the forefront of research areas.

Find out which program supports your research area (it's not always obvious). Read the program announcements before you talk to the program director so that your questions will be direct and specific. You can call or send e-mail to the program director for your program area to discuss the ideas in your proposal. Some program directors prefer e-mail; some prefer phone calls. Some don't like to talk to PIs; some do. You can ask your colleagues to find out about the current program director for your research area. Find out if there are other people you should talk to and what special initiatives might apply to you. You can find the list of telephone numbers and e-mail addresses from the NSF web site (<http://www.nsf.gov/>). Listen to what the program director says. Remember to say "thank you." (Don't be discouraged if they are rough on you. They spend all day on the phone and the rest of the time they're traveling and staying in government-rate hotels.) Treat the program directors as if they are intelligent people (even if you doubt it). The program director will assign the reviewers and will make the final decision. You don't have to be a sycophant, just be polite. (This advice comes from a former NSF program director.)

Most of your correspondence with NSF will be through email, but if you call, you will probably get the program director's voice mail. Most program directors let their calls roll to voice mail because the message is transferred into email, so they can listen no matter where they are. Also, if you are calling about a proposal or a grant, then they can have all the information at hand when they return your call. So, when you call, clearly state who you are, why you are calling, give the proposal or grant number if you have it, and give several times when you will be available for a call back. Also, oddly, the NSF phone system displays the caller ID when the call is in progress, but the number disappears after the call is over and, as far as I can tell, there is no way to get it back. So don't count on the program officer being able to see that you called. Leave a message.

The instructions to proposers get more specific every year and FastLane gets better at rejecting proposals that don't meet the formatting requirements. However, You are still responsible for ensuring that your proposal meets all the particular program requirements. Follow the directions! (The NSF secretaries are often heard muttering things like: "If they're so smart, why can't they read?")

The number of proposals submitted to NSF has increased dramatically over the last decade. As a result, fewer proposals are funded. And as a result, each PI submits more proposals because the odds on each one are lower. DO NOT submit essentially the same proposal to several programs. The proposal will probably go to at least one duplicate reviewer, who will get angry that you are burdening the system, will recommend that both proposals be rejected, and will put a black mark next to your name. DO NOT submit a proposal that is rushed and not the best that you can do. Not only are you burdening the system by making everyone go through the work of rejecting your proposal, you are also damaging your reputation with your peers. No matter what incentives you have from your university for submitting proposals, they are not worth the damage done to you and to the peer review system.

Putting together your proposal

The rest of this page follows the general flow of creating the forms and text for an NSF proposal. Once you have a rough draft of your proposal, ask someone who is senior to you to read your proposal as if they were an NSF reviewer. The ideal reader is a senior trusted colleague in your field

who has had NSF funding, has served on NSF panels, and who will not be used by NSF as a reviewer. (See Section 5.)

1. Project Summary

1 page. This is not an abstract. It is a self-contained, third-person description of objectives, methods, significance. If you are funded, this goes into NSF's Summary of Awards publication as well as being published on the NSF Web site. It will be read by your colleagues, the general public, and Congress. Be sure to include and label a section on Intellectual Merit and a section on Broader Impact.

2. Project Description

The project description has a 15 page limit. Proposals over this limit are thrown out. The formatting requirements are given in the *Grant Proposal Guide*, which you can get from the [NSF Web site](#)

. The NSF home page usually has a link to the latest version.

2.1 Objectives and Expected Significance

What are the main scientific challenges? Emphasize what the new ideas are. Briefly describe the project's major goals and their impact on the state of the art.

Clearly state the question you will address:

- Why is it important? What makes something important varies with the field. For some fields, the intellectual challenge should be emphasized, for others the practical applications should be emphasized.
- Why is it an interesting/difficult/challenging question? It must be neither trivial nor impossible.

2.2 Background and Technical Need

- What long-term technical goals will this work serve?
- What are the main barriers to progress? What has led to success so far and what limitations remain? What is the missing knowledge?
- What aspects of the current state-of-the-art lead to this proposal? Why are these the right issues to be addressing now?
- What lessons from past and current research motivate your work. What value will your research provide? What is it that your results will make possible?
- What is the relation to the present state of knowledge, to current work here & elsewhere? Cite those whose work you're building on (and whom you would like to have review your proposal). Don't insult anyone. For example, don't say their work is "inadequate;" rather, identify the issues they didn't address.

Surprisingly, this section can kill a proposal. You need to be able to put your work in context. Often, a proposal will appear naive because the relevant literature is not cited. If it looks like you are planning to reinvent the wheel (and have no idea that wheels already exist), then no matter how good the research proposal itself is, your proposal won't get funded. If you trash everyone else in

your research field, saying their work is no good, you also will not get funded. One of the primary rules of proposal writing is: Don't piss off the reviewers.

You can build your credentials in this section by summarizing other people's work clearly and concisely and by stating how your work uses their ideas and how it differs from theirs.

2.3 Research Description

Broad technical description of research plan: activities, methods, data, and theory.

This should be equivalent to a PhD thesis proposal for the big leagues. Write to convince the best person in your field that your idea deserves funding. Simultaneously, you must convince someone who is very smart but has no background in your sub-area. The goal of your proposal is to persuade the reviewers that your ideas are so important that they will take money out of the taxpayers' pockets and hand it to you.

This the part that counts. WHAT will you do? Why is your strategy an appropriate one to pursue? What is the key idea that makes it possible for to answer this question? HOW will you achieve your goals? Concisely and coherently, this section should complete the arguments developed earlier and present your initial pass on how to solve the problems posed. Avoid repetitions and digressions.

In general, NSF is more interested in ideas than in deliverables. The question is: What will we know when you're done that we don't know now? The question is not: What will we have that we don't have now? That is, rather than saying that you will develop a system that will do X, Y and Z, instead say why it is important to be able to do X, Y and Z; why X, Y and Z can't be done now; how you are going to go about making Z, Y and Z possible; and, by the way, you will demonstrate X, Y and Z in a system.

Right now, NSF is more open to application-oriented research. They need to show Congress that the money spent on research benefits the US economy. Some years ago, the word "applied" was a bad word at NSF. Now it's a good word. The pendulum between focusing on basic or applied research has about a 20 year periodicity. You always need to check to find out where it is at the moment. Check with the program director and knowledgeable colleagues.

2.4 Education and Human Resources

What are your potential contributions to developing human resources in science & engineering at postdoc, graduate, and undergrad levels?

In the last few years, NSF has started to take educational goals much more seriously. This section used to be boilerplate; it can't be any more. You need to think about what impact your research will have on education. Be specific but don't overstate.

2.5 Plan of work

Present a plan for how you will go about addressing/attacking/solving the questions you have raised.

Discuss expected results and your plan for evaluating the results. How will you measure progress?

Include a discussion of milestones and expected dates of completion. (Six months is the about the

smallest time chunk you should include in an NSF proposal.) You are not committed to following this plan - but you must present a FEASIBLE plan to convince the reviewers that you know how to go about getting research results.

For new PIs, this is often the hardest section to write. You don't have to write the plan that you will follow no matter what. Think of it instead as presenting a possible path from where you are now to where you want to be at the end of the research. Give as much detail as you can. (You will always have at least one reviewer who is a stickler for details.)

3. Results from Prior NSF Support

If any of the PIs have received NSF support in the past 5 years, you must include a summary of the results of previous work. The pages in this section count toward the total 15 pages. You can use this section to discuss your prior research and how it helps to support your current proposal. One of the purposes of this section is to help the reviewers evaluate your track record.

- Award #, amount, period
- Title
- Summary of results
- List of publications acknowledging NSF
- For renewals: relation to proposed work

4. References

Pertinent literature referenced within the project description.

Program directors often look in the bibliography for potential reviewers, and reviewers often look in the bibliography to see if their work is cited. If your bibliography has a lot of peripheral references, your proposal may be sent to reviewers whose work is not directly related to yours and who may not understand your proposal. On the other hand, if you do not cite the relevant literature, your proposal may be sent to reviewers who are not cited and who will criticize you for not knowing the literature. Most of the references in the bibliography will be cited in the Related Work section. The references do not count in the 15 page proposal limit.

5. Biographical Sketches

Educational background and career, academic essentials only. List the highlights that a reviewer of the proposal needs to know about you.

List up to five relevant publications, patents, copyrights, or software systems, plus up to five other significant publications.

Graduate students advised and postdocs sponsored in the past five years and total numbers advised & sponsored.

List long-term associates with whom you have collaborated in the past two years plus your graduate and postdoc advisors. This is for conflict-of-interest: NSF will not send your proposal to your close colleagues, your thesis advisor, nor to anyone at your current institution. You may list such people explicitly, if you wish.

Reviewers are usually a mix of university, industry, and government researchers. Almost always, the majority are academics.

6. Budget

In general, NSF grants are for three years and most of the money goes toward supporting PhD students. A typical budget for a single PI grant is about \$100K/year which will pay for a graduate student (tuition and stipend), about 10% of the professor's time to supervise the student, a little bit of travel, copying, and overhead. However, the grant size varies from division to division. Ask someone in your area what is typical.

Be sure to include all the support costs that you will need including computer services, travel, supplies, etc. NSF may cut your budget, but they'll never give you more than you ask for, so be sure to ask for everything you need.

Describe, justify, and estimate cost of equipment items \$1000 or more. If your equipment needs change between the time you submit the proposal and the time it is granted, you can still buy what you need -- But be sure to talk to the university grants office BEFORE you buy the new equipment. There are special rules about equipment money because it is usually exempt from overhead charges.

The business manager in your department or grants office will usually help you fill out the budget form once you have identified the direct costs.

7. Current and Pending Support

List all current and pending support on the given forms. Your budget office can probably help with these.

If you have submitted the same proposal to more than one agency, be sure that you declare it on the cover page and in the current and pending support section. If you don't and the same reviewer is picked by both agencies, you won't get funded and your reputation will be damaged. Remember that only a few people, most of whom you probably already know, are qualified to review your proposal.

8. Facilities and Special Considerations

This section should focus on the facilities available to you that you need to do your research. If you will rely on any specialized equipment, describe it. The question in the reviewer's mind is: Do you have the necessary resources to carry out the research? In addition, if you are asking for equipment in your proposal, you will want to make clear what equipment you don't have.

OPTIONAL: Special considerations if some work will occur off-campus

What happens to your proposal after it is submitted to NSF?

All proposals arrive at NSF electronically - mostly through www.fastlane.nsf.gov and occasionally through www.grants.gov. The proposals are routed based on the program announcement number or the NSF division given by the PI. (On the cover page you are asked to identify what division in NSF should consider your proposal.) Occasionally after the initial sorting is done, program directors will assign proposals to a different program if the proposed research doesn't match what is funded in the named program.

Once the proposal has been assigned to a program director, it is ready for review. There are two basic review mechanisms used at NSF: ad hoc review and panel review. Both are single blind peer review mechanisms: that is, the reviewers (who are the PI's peers) know who the PI is, but the PI does not know who the reviewers are.

Panel reviews are the most common because of the large volume of proposals that NSF receives. Here's the math: Most reviewers will not write reviews for more than 5 proposals a year without revolting (reviewing a proposal is a lot of work). If 150 proposals are submitted to a program, that means 900 review request must be sent out. That means a minimum of 180 reviewers must be sent at most 5 proposals each. Three reviews per person per year is more realistic - so that means the program director must have access to 300 of the proposal writers' peers in order to get the peer review system to work. And that's just for one program. All the other program directors are working with the same numbers -- and the expertise of many reviewers overlaps several programs.

Panel review: For a panel review, the program director selects 10 to 15 experts in a field and asks them review a set of related proposals. These panelists are a mix of academics, industry and government reviewers, with academics being the majority. Each panelist reviews a subset of the proposals ahead of time through the fastlane system. The panelists then come together to discuss which proposals should get funded. Most reviewers find it easier to rank a set of proposals than to write a detailed review of each proposal. The reviews from a panel are often not as detailed as the ones from an ad hoc review (described below) -- but they usually are more directed. If one reviewer completely misses the point of a proposal (which they sometimes do), this will come out during the panel discussion so you get fewer out-in-left-field reviews from panels than from ad hoc review. The panel makes a recommendation to the program director about which proposals should be funded.

Ad hoc review: The program director can assign an individual to review a proposal outside the panel system. Ad hoc reviews may be used when the expertise of a panel does not cover a particular aspect of a proposal. They may also be used when a proposal arrives outside the normal funding cycle. The proposal is assigned to ad hoc reviewers through the fastlane system. The reviewer is given about two weeks to a month to review the proposal. Again, the review happens within the fastlane system.

The program director reviews the proposal, the panel recommendation, and any ad hoc reviews, then makes a decision to fund or decline the proposal. The program directors are supposed to exercise judgment. For example, a reviewer might appear to be a perfect match for a proposal -- but when the review comes in, it may be obvious that the PI's work conflicts with the reviewers work, and the reviewer is biased.

Often the decision to fund involves deciding whether to fund the proposal at the full or reduced amount. The program director makes the decision based on the program budget, the proposals that have been funded, and the pending proposals. The program director completes a form to support the decision. The proposal goes to the division director who must concur with the decision for it to be official. You are notified by email once the decision is final. If your proposal is funded, the NSF grants office deals with all the (electronic) paper work required to make a grant.

Note: A grant from NSF goes to the institution, not to the PI. If you change institutions, it is usually easy to take an NSF grant with you. However, you must negotiate with your current and future institution. NSF will not intervene in these negotiations.

Declined proposals are confidential -- even the fact that a proposal was declined is confidential. For grants, the titles, abstracts, PIs, funding amounts, .. are public information, but the proposal itself is

confidential.

FastLane

Almost all NSF information is available over the web. The main NSF web page <http://www.nsf.gov> gives you access to all NSF program descriptions, publications (including the NSF Program Guide), program descriptions and current deadlines, the phone numbers and e-mail addresses of project directors, etc.

The FastLane system <http://www.fastlane.nsf.gov> is an interactive real-time system used to conduct NSF business over the Internet. All programs now require that proposals be submitted through FastLane or through grants.gov. The grants office at your institution can set up an account for you so that you can submit proposals and check their status through FastLane. If you are asked to write a review or be on a panel, the program officer will give you an id and password to give you access to the proposals.

Being a panelist or reviewer

Remember that for every proposal you submit to NSF, at least five or six of your peers take the time to read it, write a review, and travel to DC to discuss it. Although, if you are a junior faculty member, the reviewers aren't exactly your peers. Panels tend to be weighted toward more senior members of the community, and these are the people who will be asked to write letters for your promotion and tenure case and they are also the people who are on program committees and editorial boards. Only submit your best work!

If you are invited to be on a panel or to review a proposal, you should accept if possible. Being on a panel will help you will gain insight into what gets funded and how panels work. The peer review system only works if you, as a member of your community, understands that every proposal you submit, you incur a debt of six proposals to review. Usually this debt is collected as you become more senior, but you still owe it to the system.