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Executive Report:

How to Write a Winning NSF Proposal

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Thank you for ordering “Executive Report: How to Write a Winning NSF Proposal” from the Principal Investigators Association Library. This resource is designed to help you better understand — and more successfully complete — the Project Summary, Intellectual Merit and Broader Impact portions of your National Science Foundation (NSF) grant proposal.

Michael Lesiecki, PhD, served as co-author for this report, and we gratefully acknowledge his input. Dr. Lesiecki has served as the executive director of the Maricopa Advanced Technology Education Center (MATEC), an NSF-funded center of excellence, since its inception in 1996. Dr. Lesiecki has published 27 technical articles and has received one patent. He has served as Principal Investigator on successful, major NSF proposals and serves as a reviewer for NSF and the U.S. Department of Labor grant proposals.

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Best Regards,
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Executive Summary

Like most other grantors, the National Science Foundation (NSF) has specific instructions on how you should develop, write and submit your proposals. Perhaps the most important elements that the NSF wants to see in your proposals are the merit-review criteria developed by the National Science Board (NSB).

The NSF instructs its reviewers to rate proposals based on two merit-review criteria: Intellectual Merit and Broader Impact, according to Michael Lesiecki, PhD, the executive director of the Maricopa Advanced Technology Education Center. Dr. Lesiecki has 14 years of experience as both an NSF reviewer and a principal investigator (PI) on major, successful NSF proposals.

Addressing Intellectual Merit and Broader Impacts in your NSF grant application is the crucial element to drafting not only a proposal that reviewers will view favorably, but also one that the agency won't return to you without even reviewing it. In fact, these two criteria are so important that you must separately highlight both in your Project Summary page, as well as throughout the rest of your proposal.

And reviewers, Program Officers and Division Director will review your proposal looking for these specific elements. According to Dr. Lesiecki, to write a winning NSF proposal you must:

- **Write with the reviewer in mind** — and think like one while you're developing your proposal. Make his job easier by clearly identifying in your proposal the key elements that he's looking for.
- **Study the NSF grant criteria** carefully before you begin any work on your proposal. Understand not only the general grant-proposal guidelines, but also the specific criteria under the applicable agency program and specific funding opportunity.
- **Highlight the Intellectual Merit and Broader Impact** items in your Project Summary. State these criteria clearly and visibly to avoid a return of your proposal.
- **Use summary paragraphs** throughout your proposal to reinforce its Intellectual Merit and Broader Impacts. ■

CHAPTER 1:
Your Project Summary: Bring Out Intellectual Merit and Broader Impact

Your one-page Project Summary is one of the most important elements of your NSF proposal because this is your opportunity to drive home your project's importance and scope in a single page. Your Project Summary shouldn't look like an abstract of the proposal, "but rather a self-contained description of the activity that would result if the proposal were funded," the NSF states.

NSF states that your Project Summary should include specific items, particularly a summary of the Intellectual Merit and Broader Impact. The reviewer will look for these two items first. *If you don't include Intellectual Merit and Broader Impact in your summary page in distinct and separate statements, the NSF will automatically return your proposal without reviewing it.*

Strategy: Think Like the Reviewer

To facilitate your reviewers' positive impression of your grant application, make your summary page informative and understandable for people who are working in the same or related fields and scientifically- or technically-literate lay readers. Understanding the reviewers' instructions and what they need to provide to Program Officers can also help when drafting your Project Summary and the rest of your proposal.

Here's what the agency wants to see in your Project Summary:

- The Intellectual Merit of the proposed project;
- The Broader Impacts of the proposed project's results; and
- A summary written in the third person that's no more than one page long.

Each NSF reviewer typically assesses 10 to 12 proposals and spends only 90 to 120 minutes on each, Lesiecki estimates. That's a very short amount of time, especially after you've spent weeks or months preparing the proposal. Therefore, your best bet in getting your application to the top of the pile is to write it with the reviewer in mind.

An effective Project Summary that clearly calls out all the required elements can help you to accomplish this, as well as help the reviewer to write her recommendation statement using the language that you want to communicate to the NSF decision-makers. In fact, the reviewer is actually looking for specific words and language in your proposal that she can use to draft her review.

If you leave out one of the specific elements NSF reviewers are looking for, they might return your proposal or send it to the bottom of the pile.

State Your Intellectual Merit and Broader Impact

No PI wants his proposal returned without review. So you'll want to make the initial assessment easy for the reviewer. Write distinct statements in separate paragraphs for Intellectual Merit and Broader Impact. Put "Intellectual Merit" and "Broader Impact" in bold, so that the reviewer can see that you've met these two criteria right away when she first looks at the Project Summary page.

Here's a good real-life example of effectively using the Project Summary to state your Intellectual Merit and Broader Impact, from the NSF-awarded project "Effect of Activated Sludge Bioselector Designs on Estrogen-Degradation Kinetics":

> The **intellectual merit** of the project is its transformational approach, which integrates modeling the fate of a micropollutant in a biological process with a fundamental co-substrate mechanism, bioselector design effects, and microbial composition based on molecular methods. A second potential far reaching benefit will be the development of pure cultures capable of EE2 degradation under conditions similar to a wastewater treatment plant (WWTP) for future kinetic and genetic studies, and development of qPCR primer sets for monitoring select EE2-degrading heterotrophs in WWTP facilities.
>
> The **broader impacts** of the project are benefits to society by providing a basis to optimize WWTP biotreatment design to minimize estrogen release to the environment. Direct educational benefits include the training of graduate students, and participation of undergraduate researchers. Increased participation by under-represented groups will be realized through established university programs and continued partnership with the Office of Diversity.

Also keep in mind that although the reviewer is looking for these specific items and criteria in your Project Summary and throughout your proposal, the NSF also encourages reviewers to "think holistically." Instead of addressing each of the review criteria singularly, Program Officers want reviewers to identify the project proposal's overall strengths and weaknesses or concerns. ■

CHAPTER 2:
Keep Intellectual Merit Front-and-Center

As part of the two main merit-review criteria, the NSF reviewer will delve into and rate the Intellectual Merit of your proposed work based upon five main criteria:

1. How **important** is the project?
2. How **well-qualified** is the PI and other involved individuals?
3. How **creative, original** or potentially **transformative** is the proposal?
4. How **well-conceived and organized** is it?
5. How **well-resourced** is the proposed project?

You should clearly address each of these five items in your proposal, using easy-to-identify language so that the reviewer can recognize them right away. Also, you can write short summary statements at the end of each section to reinforce your points and ensure that the reviewer simply can't miss the project's importance, transformative aspects and so on.

Importance: Don't Be Afraid to State the Obvious

When the reviewer submits her summary to the Program Officer, she'll rate the importance of the proposed work. You are extremely familiar with your work's significance because you're well-versed on the literature and input from your colleagues. But the reviewer needs clear statements in your proposal that define your project's magnitude.

Follow three key steps to communicate your work's importance to the reviewer:

1. **Help the reviewer do her job.** Give her the clear language in your proposal to easily identify the importance of your project. You can write: "This work is important because…" State the obvious because what may seem obvious to you is not necessarily to the reviewer.
2. **Write in your discipline's language to make a scientist-to-scientist connection.** Remember that the reviewer is a scientist, and you're speaking to a scientist in your proposal. Writing from your scientific point of view will greatly increase your credibility in the reviewer's mind, further bolstering her sense of Intellectual Merit. In your proposal's wording, use common acronyms and abbreviations used in your field, and write as if you're talking to a fellow scientist.
3. **Grab the reviewer's attention.** If you can clearly state an urgent or timely issue related to your project, this can help to capture the reviewer's attention and interest. It will also help to rank the Intellectual Merit higher.

Say something along the lines of: "We need to understand the results of this study because …" and express a timeline or urgency in your explanation.

Qualifications: Remind the Reviewer of Your Team's Experience

The reviewer can get a good sense of how well-qualified your team is by reading your attached curriculum vitae, but you should reinforce this point within your proposal. Don't make the reviewer hunt through the attachments to find this information. Instead, bring your qualifications right to the forefront.

When you're discussing the personnel in your proposal, remind the reviewer of the exact qualifications of all your team members. Call out these qualifications clearly, and don't shy away from using the term "well-qualified." In your summary statement at the end of this section, you can write: "The investigators are particularly well-qualified based on their background and experience …"

Creative, Original or Transformative: Use Italics to Catch the Reviewer's Eye

The reviewer will consider how creative, original or potentially transformative your proposed project might be. The NSF is looking for proposals that could move the field into a brand-new direction or change the state of the art in a new and innovative way.

So again, call attention to any key words, and tell the reviewer exactly why you feel your activities are potentially transformative and how aspects of your work can transform or change the field. You can even italicize the statement. For example: *"There are potentially transformative aspects of the proposed work, which if successful could …"* Or: *"These activities are potentially transformative because…"*

Conception and Organization: Give a Good Impression With Proper Formatting

Another criterion that the reviewer will consider for Intellectual Merit is: How well-conceived and organized your proposal Is. Unlike the other criteria, you shouldn't call this out in your proposal by writing that "this proposal is well-conceived and organized," because the proposal as a whole should convince the reviewer of this point.

If you organize your proposal to carefully follow the NSF's guidelines for the proposal components, the reviewer will likely view your proposal as well-conceived and organized. Another key element is to adhere to the agency's rules regarding font sizes, margins and other formatting elements.

Pitfall: Don't try to cram your proposal full of information by playing around with the margins or making the font size extra small. You may find fitting everything you want to say into the 15-page limit difficult, but resist the urge to use formatting tricks to fit more in because you will sacrifice the readability. You don't want to discourage the reviewer by something as simple as your font size, nor do you want to ignore the clearly-set guidelines.

Follow the NSF's key formatting points:

- Keep all your margins to at least 1 inch.
- Ensure that a vertical space of 1 inch contains no more than six lines of text.
- Set the font size at 10 points or larger for Arial, Courier New or Palatino Linotype fonts.
- Keep your font size at 11 points or larger for Times New Roman and Computer Modern-family fonts.
- Use font sizes of less than 10 points only for mathematical formulas and equations, Symbol-family fonts, and captions for diagrams, tables or figures. Although you're allowed to use a smaller font size for these instances, be sure to make the font large enough for readability.
- Don't use two-column formatting to prevent problems for reviewers who read your proposal electronically.

Well-Resourced: Tell the Reviewer About the Tools at Your Disposal

The fifth criterion for Intellectual Merit is how well-resourced the proposed project is. What the reviewer is looking for here is assurance that you either have laboratory facilities to perform the proposed activities or that you have access to the facilities and equipment.

The reviewer won't assume that you already have the resources that you need for the project — you need to tell her this clearly in your proposal. In the summary statement, you can even write: "This project is particularly well-resourced for the following reasons …" ■

CHAPTER 3:
Describe 'Broader Impact' Artfully — And Make It Your Theme

The real key to addressing Broad Impacts is to think beyond your project's scope. The NSF reviewer wants to not only see the importance of your project, but also understand what greater impact your work could have on your field, the related technology or infrastructure, and society as a whole.

There are five main aspects that the NSF will consider regarding Broader Impact:

1. Does the proposed project advance **discovery and understanding** while promoting **teaching and learning**?
2. Does it address **under-represented groups**?
3. Will the project enhance the **infrastructure** for research and education?
4. Are you **disseminating broadly**?
5. Does the work offer **societal benefits**?

Note: You don't need to address all five of these items for Broader Impacts, but you should address the ones that are most relevant to your work.

How to Describe Your Work's Impact on Promoting Teaching, Understanding and Discovery

To demonstrate how your project will advance discovery and understanding while promoting teaching, training and learning, give the reviewer specific action items and collaborative agreements. The NSF offers several different examples of activities that you can employ to address this:

- Develop and contribute educational materials based on your research that you can include in a teaching database like a K-16 digital library;
- Involve K-12, undergraduate or graduate students as participants in your research;
- Integrate your project activities into K-12, undergraduate and graduate teaching of science, math and engineering;
- Collaborate with educators and researchers to incorporate your research into learning and education;
- Involve your graduate and post-doctoral student researchers in undergraduate teaching activities;
- Invite student teams involved in your research to make presentations to professional societies;
- Establish mentoring programs for high school, undergraduate and graduate students, as well as research technicians; or

- Involve your team and your project activities in the recruitment, training or professional development of K-12 math and science teachers.

Identify Under-represented Groups Addressed in Your Project

To tell the reviewer exactly how your work will broaden the participation of under-represented groups, you cannot simply state your university's minority demographics. Instead, you must plan how you will involve these groups — which include women, ethnic groups and disabled individuals, as well as geographically-limited groups — in your work more broadly. .

The following are some NSF examples of how you can address this Broader Impact point:

- Involve students from under-represented groups as participants in your proposed activities;
- Seek out educational and research collaborations with minority students or faculty;
- Collaborate with students and faculty from non-PhD-granting institutions and institutions serving these groups;
- Mentor scientists and engineers from under-represented groups who are new to submitting NSF proposals;
- Participate in workshops and conferences in which diversity is a priority;
- Develop new approaches like information technology and connectivity to reach out to under-represented groups, communities and individuals;
- Collaborate with faculty and students at EPSCoR (Experimental Program to Stimulate Competitive Research) institutions, colleges for women and community colleges; or
- Visit campuses and establish education collaborations at institutions that serve under-represented groups.

Example: You're writing a proposal in social psychology about acculturation. How can you identify a Broader Impact relating to under-represented groups?

In this case, you could collaborate with local and government agencies to design a program that would help teach immigrants how acculturation works. Or you might try partnering with non-governmental agencies that serve under-represented groups. You can try a blend of non-governmental and government organizations to accomplish this Broader Impact item, showing the reviewer that your research is involving other "on-the-ground" agencies that have clients who can benefit from your proposed research.

Explain Your Project's Impact on Research and Education Infrastructure

There are several ways you can show your research activities enhance the infrastructure for research and education. The NSF offers the following tips:

- Collaborate with researchers and institutions in other disciplines, particularly with other U.S. academic organizations, as well as government and industry with international partners;
- Develop and operate shared research and education infrastructures, such as science and technology centers, engineering-research centers and other facilities;
- Involve your team in developing and disseminating next-generation instrumentation, multi-user facilities and other types of shared platforms;
- Improve or upgrade computing infrastructures, such as large databases, digital libraries, or networks and associated systems; or
- Develop methods to expand multi-user facilities so that they're sites of research and mentoring for larger numbers of engineering and science students.

Make an Impact With the Reviewer Using Information Dissemination

The NSF reviewer wants to see how you'll disseminate the information gained from your research to make the broadest, greatest impact. Your proposal should explain how you'll effectively inform others regarding your project's results to enhance scientific and technological understanding. This criterion generally speaks to your interaction with professional societies.

Most professional associations and societies have educational-outreach arms that offer excellent dissemination and impact opportunities for your work. They can even provide you with letters to include in your proposal that confirm that they society would like to collaborate with you to distribute your work through specific means. Additionally, the NSF offers the following examples to help you address broad dissemination:

- Integrate your research with educational activities to communicate your information in a larger context;
- Participate in multidisciplinary research activities, conferences and workshops;
- Collaborate with nature centers, museums, science centers and other similar organizations to create exhibits related to your work;
- Involve the public or the related industry in your research and education activities;
- Give presentations to the broader community at libraries, museums and other public venues;
- Offer data derived from your work for inclusion in databases and digital libraries;
- Publish your data in a wide variety of formats, such as CD-ROMs, press kits, Websites and non-technical literature; or
- Offer research results and educational materials in useable formats for Congress members, industry leaders, policymakers and other audiences.

Highlight How Your Work Will Benefit Society

Demonstrating your project's benefits to society is among the most difficult Broader Impact items, but it's also one of the highest-ranking items for reviewers.

Some good ways to communicate societal benefits to the NSF reviewer include explaining how you will analyze, interpret and share your research results in a variety of different formats that non-scientists can easily understand. Another way is to collaborate with scientists at federal government labs and agencies. Here are some additional suggestions:

- Partner with private-sector scientists to integrate your research into broader activities of national interest;
- Explain how your research and discovery will benefit society by supplying specific examples of the results' possible application; or
- Supply information derived from your research to federal, state or local agencies for their use in policy development. ■

APPENDIX A:
Understand the NSF Review Process to Get a Leg Up

A good understanding of the basic NSF review process can help you prepare and submit proposals, as well as throughout the evaluation process. Here's the rundown of the NSF Proposal and Award Process:

Phase I: Proposal Preparation and Submission (90 Days)

1. The NSF announces the funding opportunity.
2. You submit your proposal.
3. The NSF receives your proposal and assigns it to the appropriate NSF program.

Phase II: Proposal Review and Processing (6 Months)

1. The NSF selects reviewers, assigning at least three external reviewers to each proposal.
2. The peer review is conducted. The reviewers read over the proposals and submit their statements and comments to the Program Officers.
3. The Program Officers analyze the reviewers' statements and make their recommendations to the Division Director.
4. The Division Director reviews the recommended proposals from the Program Officers.

Phase III: Award Processing (30 Days)

1. The Grants and Agreements Officer conducts a business review of all approved proposals.
2. The NSF finalizes the award, and the Grants and Agreements Officer notifies you of the award decision.

As you can see from the estimated timeframes for each phase, the proposal-review process is rather lengthy. In fact, you can expect to wait up to one year after the submission date to receive an award. In some cases, you could receive an award as quickly as five months after the submission date, but this isn't common.

The NSF groups reviewers under a single directorate, so they work on proposals only in that specific directorate. Typically, a panel of 15 to 18 reviewers assesses the proposals under the directorate.

When the reviewer panel finishes its recommendations, comments and statements, the Program Officer for that directorate then examines the proposals. The Program Officer not only looks at the reviewers' comments on the proposals, but he also reads the actual proposals. A Program Officer will read most carefully those proposals closest to the funding line. ■

APPENDIX B:
Top 6 Tips for NSF Proposal Success

There are several common mistakes that PIs make — and you'll want to avoid — when they're drafting and submitting NSF proposals. Also, there are certain proposal elements that you can tweak in a specific way to gain an edge over other submitters. Here are your top tips for gaining the reviewer's admiration and interest:

1. **Don't over-write your proposal.** Many PIs mistakenly use formatting tricks like narrow margins and small font sizes to include more information in their proposals. Not only is this against the NSF's proposal guidelines, but it also deters the reviewer because she can't easily read your proposal. Steer clear of making your proposal too dense without a regular font size and frequent paragraph breaks.
2. **Spend some time writing your one-page Project Summary,** instead of throwing it together at the last minute. Remember that the summary page is the first thing that reviewers will turn to because it outlines the proposal's overall contents. Don't simply cut-and-paste paragraphs from your proposal. Instead, draft an original Project Summary that will grab the reviewer's attention and make her understand the importance of your proposed work.
3. **Avoid undercutting your work plan.** Although reviewers want to see a clear, detailed explanation of your work's significance and importance, don't shortcut your work plan. Remember that they also want to see how you're going to do it. Put yourself in the reviewer's shoes, and think about what she would want to see in your proposal after you've convinced her that you have a good project idea. A detailed work plan illustrates exactly how you're going to accomplish your proposed activities.
4. **Flesh out your budget's details.** You don't have to go overboard on your budget's finer points, but you should at least provide the reviewer with the level of detail that you can estimate regarding expenses. For example, if you know that your travel budget requires roughly $500 in airfare and four days per diem at $160, list this out. Don't just give the reviewer the total estimate of $1,140.
5. **Don't shortcut your budget.** At the same time, provide a solid, justified budget. Rather than cut yourself short, ask for exactly what you need in terms of funding. This is what the reviewer wants to see — a realistic budget instead of made-up numbers.
6. **Win with your words.** Use the language in your proposal that you want to see in the reviewer's recommendations to the Program Officer. Help the reviewer draft her comments on your proposal by stating items clearly and in a manner that she can use. ■

APPENDIX C:
FAQs: NSF Proposals and Merit Review

How can I get a sample proposal from NSF?

You can obtain samples of proposals in two ways: 1) Use the Freedom of Information Act (FOIA); or 2) contact the Program Officer. Although the first method will work, the second method is probably much easier and less time-consuming.

You can find the Program Officers' names and contact information on the proposal or "solicitation." Simply contact one of the Program Officers, and discuss your proposal ideas with him and ask for sample proposals of recently-funded projects. The NSF actually encourages prior contact with Program Officers.

The Program Officer can direct you to where you can find published proposals, particularly ones in your directorate area. He can also give you some inside information on whether the NSF has recently funded a similar project to yours and whether it would consider funding a similar project in the near future.

What's the most important advice for collaborative proposals?

A collaborative proposal is a unified research project involving PIs and researchers from two or more organizations or universities. You can submit collaborative proposals in two ways: 1) as a single proposal under which the lead organization receives a single award and administers sub-awards; or 2) as simultaneous proposals submitted from each organization for separate awards. The first scenario is usually the more common type of collaborative proposal.

The most important part of submitting collaborative proposals is identifying a lead for the group project. The NSF wants to see that a single PI or organization will be responsible for heading up the project, appropriately doling out the award funding, and organizing compliance and reporting efforts throughout the project.

Another key element in collaborative proposals is showing true teamwork among the researchers and organizations. You must illustrate in your NSF proposal exactly how — in your budget, work plan and other parts of the proposal — the different organizations will partner on the project. Don't just say that you're working with this other organization; explain how everything will work.

Finally, keep in mind that the NSF won't necessarily allow you to exceed the 15-page Project Description limit just because you're submitting a group or collaborative proposal. Unless the specific program solicitation stipulates that you can exceed this page limit on group proposals, you'll need to stick to the 15 pages under the agency's

Grant Proposal Guide. If you want to exceed the page limit, you can request a deviation on the rule — but be sure to request the accommodation *before* submitting the proposal.

Are there conflict-of-interest guidelines for reviewers?

The NSF asks reviewers to evaluate and report potential conflicts of interest (COIs) for each proposal that they're assigned to review. The reviewer has to answer questions like:

- Could I benefit financially from this proposed project?
- Would my children or spouse benefit financially from the project activities?
- Do I own stock in a company mentioned in or related to this proposal?

If the reviewer answers "Yes" to any of the questions, she has to report the COI to the NSF and withdraw herself from reviewing the proposal. The reviewer may also become "conflicted out" of the entire panel.

Additionally, the agency allows you to suggest certain reviewers to exclude from assessing your proposal, which you can stipulate in a page among your "single-copy documents" that are for agency use only. You can include a document listing suggested reviewers or individuals who you prefer not to examine your proposal, but you must explain why. Ultimately, the Program Officer holds the discretion whether to heed these suggestions.

Can I submit the same proposal to NSF and other agencies simultaneously?

Even if you think that multiple programs might review your proposal, you should still submit only one proposal to the NSF. You, however, can specify which NSF organizational units are most appropriate to review your proposal. You can also submit concurrent proposals to the NSF and other agencies.

If you're submitting your project to the NSF and another agency, be sure to let both entities know that you're doing this. They might decide to review the proposal jointly or even fund the award for the project jointly.

Why would NSF return a proposal?

There are several reasons why the NSF could return your proposal without reviewing it, some of which are more obvious than others. For example, the agency will return a proposal if it's inappropriate for NSF funding, submitted with insufficient lead-time prior to the project's scheduled start date, or a duplicate or significantly similar to a proposal by the same submitter.

The NSF will also return proposals if:

- You received a "not invited" response on your preliminary-proposal submission, meaning that the NSF turned down your preliminary proposal and didn't invite you to submit your full grant proposal.
- Your proposal doesn't conform to the page-limit, formatting or electronic-submission guidelines set out in the Grant Proposal Guide or program solicitation.
- You don't meet the announced proposal deadline date.
- Your proposal duplicates another that the NSF already awarded.
- You resubmit a previously-declined proposal without making substantial revisions. You must take into account the agency's significant comments and concerns on your declined proposal when you're redrafting it. If you have made substantial revisions, then the NSF will treat the revised proposal as a new one.
- Your one-page Project Summary doesn't separately address both merit-review criteria: Intellectual Merit and Broader Impact. ■