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March 2010

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Recommended Citation

Powell, Jim; Sullivan, Kim; and Anderson, Anne, "Getting Grants at the National Science Foundation" (2010). *ADVANCE Library Collection.* Paper 208.
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Getting Grants at the National Science Foundation

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Objectives

The goal of the ADVANCE program at the National Science Foundation (NSF) is to increase the recruitment and retention of women and minority faculty in sciences and engineering. On the retention side of the equation, under-represented groups on a national scale report less inclusion in research information networks and funded, collaborative research and eventually dissatisfaction with their jobs. At Utah State, the ADVANCE Supportive Workplace Initiative is focused on increasing the success and satisfaction of all faculty members with their work environment. Part of our efforts are focused on building and strengthening collaborative research networks, improving information flow about good grant-getting practices, and thereby providing a more supportive professional environment for everybody. Since a rising tide floats all boats, these efforts will serve to increase success and retention of women and minority faculty members.

Given these objectives, we have been invited by Brent Miller, VP for Research, to organize a workshop on getting grants at the NSF. With the support of some of Utah State's leading grantspeople we have compiled the following 'best practices' suggestions. Funding rates in disciplinary, 'core' science programs at NSF vary from 10 to 30 percent, but institutionally NSF is placing an ever-increasing share of its budget into large, collaborative, multidisciplinary research. In these initiatives funding rates are often much lower (e.g. 5-7% in the BioComplexity program), and for Utah State to continue to be a nationally competitive research institution we will need to be a much more networked faculty, taking care to provide mentoring and disseminate the knowledge of successful senior faculty members.

The NSF is the national agency concerned with advancing scientific knowledge and promoting Science, Technology, Engineering and Mathematics (STEM) education. The Foundation funds intellectual efforts which generate new results in the open scientific community, and it encourages transmission of those results through educational and outreach efforts. The NSF itself is quite helpful about information, maintaining searchable databases on funded proposals, funding opportunities, program officers, and reports and self-assessments. All of this information is available at the NSF web site, http://www.nsf.gov. Program officers view it as their job to make sure the pool of proposals coming to their programs are broad and strong, and consequently they are generally forthcoming with information and encouraging to investigators that they have not heard from before.

All proposals are evaluated on **Criterion I (Scientific and Intellectual Merit)** and **Criterion II (Societal and Broader Impacts)**. Criterion I includes all issues related to the scientific impact of the research, likelihood of success, sufficiency and clarity of the hypotheses, methods and approaches to be used. Criterion II includes undergraduate, graduate and postdoctoral training

and mentoring, outreach to society at large, recruitment and mentoring of students and researchers from underrepresented groups, integration of teaching and research, conservation/management of species which are endangered or which have potential impact on society, scientific or engineering issues which have impact outside of academe. Given that NSF programs generally fund less than one proposal in every four or five, the onus is on the proposal writer to demonstrate excellence in both criteria. Not addressing Criterion II at all will result in your proposal being declined without review.

Proposals are submitted almost totally electronically to NSF via FastLane, which allows for all proposal components to be submitted individually. The default format for submission is PDF, although Word and LaTeX documents can be submitted for conversion to PDF on the NSF end of things. Individual components of the proposal are outlined in the **Grant Proposal Guide** (available at http://www.nsf.gov), which describes how the default proposal should be structured. If you have never submitted a proposal before, look through the GPG so that you are aware of what components are generally required of a proposal. You will also need to contact the Sponsored Programs Office (SPO) on campus (http://www.usu.edu/vpr/funding/programs) so that you can get a password for the FastLane system. The SPO will be running workshops on submitting proposals via FastLane and university forms in the near future, more details will be available at the Science Faculty Social sponsored by the ADVANCE Supportive Workplace Initiative (24 November 2003 at the Caine House, see **Upcoming Events** below).

This document is organized as a sequence of tips and info-bits for PIs in the following broad areas:

- The Review Process (who is the real audience?)
- Tips for the PI (selling to your real audience)
- Criterion I Proposal Content (intellectual merit the audience is looking for)
- Criterion II Proposal Content (what are the broader impacts for the audience?)
- Proposal Structure (making it possible for audience to find what they want)
- Writing Tips (making sense to the audience)
- Evaluation and Accountability (convincing the audience it will be done well)
- Initiatives and Multidisciplinary Proposals (tough audience, giving big grants)
- Upcoming Events and Contact Information (more help and opportunities)
- Acknowledgements (those who helped us reach *our* audience)

The Review Process

1. There are really three levels of review occurring at NSF – review by mail reviewers (scientists to whom individual proposals will be sent with solicitation for their opinions about the feasibility, impact, and likelihood of success of the proposed activity), review panels (groups of scientists who visit NSF for short periods of time for the specific task of competitively evaluating from 10-150 proposals for a given subject area or initiative), and the program officers (who make decisions about which proposals to fund at what level, guided by the mail reviewers and panelists). Different programs at NSF use one or more sources of peer review (mail only, panel only or mail and panel). **These reviewers are your real audience**, and to be successful in reaching them you should know what review process will be used in the program to which you are applying.
2. **Mail reviewers** are likely to be experts in closely related subject areas, who can provide feedback on the relevance and feasibility of the proposed research. They are often relied on by the panelists and program officers, who may not be well acquainted with details of the subject area. More often than not reviewers are individuals with current or past NSF funding or experience.
3. **Panel review** is generally competitive, with specific panelists given primary responsibility for reading and presenting some subset of proposals to the other panelists. Panels are generally chosen to represent a diversity of opinions, both scientifically and culturally, from among people with doctorates or equivalent credentials. Proposals are ranked into categories (some version of highest funding priority, lower funding priorities, fund if possible and do not fund). Proposals within a category are considered to be similarly ranked. NSF, unlike NIH, does not numerically rank proposals. Panel recommendations are advisory to program officers. Proposals must excite panelists to receive the top rankings (someone in the room must be saying – "Wow, this is incredible").
4. **Program officers** make the final decisions on funding proposals, generally guided by the evaluations of reviewers and panelists. They can (and do) make decisions to fund particularly meritorious proposals, even when other reviews are mixed. Program officers, as a group, tend to be politically liberal, more diverse in race and gender than faculty in the fields they represent, concerned about fairness and equity, and motivated toward advancing science in general and their program area in particular. More often than not they would like to spread the wealth and make sure young, bright investigators get support and encouragement. About two thirds of program officers are 'rotators' who choose to work for one to three years at NSF and will then return to faculty positions at their home institutions.
5. Program officers are always looking for **ways to stretch their program budget**. If they are deciding among similarly ranked proposals and partial funding is available for one of the proposals from another source at NSF, they will fund that proposal. Partial funding or matching funds are often available for proposals with a PI from an EPSCOR state, a minority serving institution, a primarily undergraduate institution, for a PI from an underrepresented group, for proposals that incorporate advances in math and IT with discipline specific research, for Career proposals, for long term studies, for international

collaborations, for proposals bridging research areas, for proposals incorporating new technology, and for proposals with exceptionally strong Criterion II.

6. There is always a field in the FastLane proposal system in which PIs can **suggest reviewers for the proposal**. Use it – this helps the program officers, who may not be acquainted with many front-line researchers in your field, and it helps you because you can be sure to suggest people who can clearly see the merits of what you propose. Do be careful not to suggest reviewers with whom you have an obvious conflict of interests (i.e. written a paper, supervised or been supervised by in the last five years).

Tips for the PIs

1. **Establish contact with your program officer(s)**. These are the individuals who will make the final award decisions. They know best what they are looking for and this is particularly important for initiatives. If possible, visit your program officer at NSF or talk to them at scientific meetings. If your proposal is declined, contact the program officer to help interpret the comments of reviewers and panelists. Which comments weighed most in the decision to decline the proposal? Should you revise the proposal and resubmit?
2. **Find out who is likely to be on the panel** if there will be a panel review. If they are experts in related areas, try to find an opportunity to cite their research in your bibliography. Ditto with suggested reviewers. On panels, these people are most likely to be given the task of presenting your proposal to the reviewers, and this is a great way to give them a warm and fuzzy feeling about the proposed work.
3. **Do not annoy your program officer**. You want them to work hard to find funding for your proposals. If you are asked to review proposals, do at least 1-2/year. Program officers do not like scientists who receive funding from NSF but do not review proposals and keep lists of "famous deadbeat reviewers" in their desks. Get your annual reports in on time. Do not call up your program officer as soon as you get your reviews and yell at them. Do not sic your Congressional representatives on them.
4. **Offer to serve on a panel**. You will gain valuable insights into the review process and what makes a proposal competitive.
5. If at first you don't succeed, **try and try again**. It is common for successful proposal writers to rewrite subsequent proposals taking advantage of the written reviews they receive from failed proposals. The Population Biology Program analyzed success rates of male and female Principle Investigators. They found that individual proposals by men and women were equally likely to be funded. But men had higher career funding rates because they were more likely to **resubmit declined proposals**.
6. When you resubmit, **gently address the previous reviews**. It is more than possible that some of the reviewers will be asked to review the proposal again, and certainly the program officer will know about the content of the reviews. You need to show that you are cognizant of the reviews, and have taken steps to address whatever concerns were raised. You may need to humble yourself and swallow your pride, but it is worth it because past reviews will otherwise hover like a lingering stench over your revision.

7. Attend scientific meetings, join committees and volunteer to **get yourself known**. Some of your unknown reviewers will come from the pool of persons you interact with in these venues.
8. Do background research on the type of **research likely to be funded** (if well developed). Viewing lists of projects previously funded by a particular program, consulting program officers, peers already successful at NSF, etc. The awards database at NSF is (in principle) fully searchable by area, program, program officer, year, investigator and subject – use this information to enhance your success!
9. When you are looking for funding avenues at NSF, **don't restrict yourself to obvious (disciplinary) programs.** Look at cross-cutting programs (NSF funding which crosses disciplinary boundaries), Small Grants for Exploratory Research (SGER, or 'sugar', grants), International Programs, and Research Collaboration Networks.

Criterion I Proposal Content

1. **Solidity vs. Novelty**. Successful proposals are not just solid (scientifically feasible, answering questions of current interest with techniques that are likely to work and personnel who can implement them) but also include novel ideas which could potentially have significant, as opposed to incremental, impact. It is important to make the case for what is new and different in the proposed activity, and why it is likely to have larger impact. NSF likes to fund research which has an element of risk now, but will become mainstream in two to three years.
2. Be careful to connect your research to what has been done and the major thrusts of thought. Show that you are aware of and respect the current wisdom, even if what you are doing may contradict it, in part. Discuss how this proposal **fits in the broader scientific context**. This will reassure reviewers as to the solidity of your work.
3. **Establishing new connectivity** between new areas often sells well in a proposal. On the one hand, it can increase the novelty factor, while on the other hand conveying a sense of high probability of success as what is novel in one area has already worked effectively in another area.
4. **Include (and develop!) preliminary data** to demonstrate the tractability of the work and, hopefully, the magnitude of the effects you purport to demonstrate in the proposed research.
5. Particularly for disciplinary proposals, **describe techniques in enough detail** to convince reviewers that you have the required expertise. But be careful to preface the detailology with an overview so that less expert reviewers know what they are missing.
6. Your budget needs to be reasonable, but don't be afraid to **ask for what you really need** to get the research done. There are three pages allowed for appending a budget description in which you can justify you requests, and these pages are seldom used by PIs!
7. Develop a **strong abstract** that stands on its own, builds excitement, and conveys the basic thrust of the proposal. The abstract is the only part of the proposal that many panelists will look at! However, don't obsess about the abstract early on; these can be very hard to write, and may only come together at the *end* of the writing process.

Criterion II – Broader Impacts

1. Criterion 2, the **broader impacts** requirement for proposals submitted to NSF, is a serious part of proposal evaluation. Criterion 2 strengths will not make up for weaknesses in the basic intellectual merit and novelty of a proposal, but good proposals (from a scientific perspective) are often down-checked by reviewers if they ignore broader impacts.
2. Every proposal can have a strong showing with respect to broader impacts. Consider:
    - **Educational** aspects: integrating research with teaching, including undergraduates in research, including a K-12 teacher as a summer researcher assistant, offering to lecture to an Honors class at a high school, giving undergraduate seminars as well as professional colloquia when visiting another university. We have an experimental school on campus, as well as many science discovery camps that occur in the summer – could some aspect of your research be communicated in these venues?
    - **Mentoring**: providing professional/career mentoring for scientific participants at all levels, undergraduate, graduate, postdoctoral, and junior faculty. Consider mentoring a faculty member at a primarily undergraduate college (possibly a former student). Extra points can be scored if any of these participants are from underrepresented groups in science and engineering. Could you sponsor a mentoring program for students/young postdocs at a national meeting in your research area?
    - **General outreach**: funding a student to produce posters/exhibits on your research for general audiences, participating in an interview for Utah Public Radio (e.g. "Access Utah"), funding a journalism major to specialize in writing some public-consumption articles on the science being proposed.

    - Are *you* a 'broader impact'? Don't be afraid to mention if you are part of an **underrepresented** group, or if you are a **new PI**. This by itself may seem like asking for sympathy, but if you can link it with a mentoring plan, clear plans to serve as a role model, mentor or in a recruiting or outreach role this is a legitimate Criterion 2 impact.
3. Try to **seriously integrate the Criterion 2 elements** of your proposal with the main thrust (for example, if you plan to include a teacher as a summer research assistant, mention elsewhere what their job will be and include them in the management plan) – if the broader elements appear to be 'tacked on' they may not be taken seriously.

Tips for Proposal Structure

1. Include a **dissemination plan** for results, with projected publication dates in the timeline of deliverables. Remember that *everybody* will say they are publishing papers and hunching out steaming piles of HTML. Consider some novel dissemination ideas that enhance other proposal elements, for example:
    - Sending undergraduates/graduates to present posters at national meetings,
    - Integrating research/teaching,
    - Sponsoring 'short courses' in elements of the proposed work with broad impacts,

- Organizing symposia or workshops at national meetings.

2. A **graphical timeline** for accomplishment and **table or chart of responsibilities** of primary personnel helps convey an image of forethought and organization.
3. Your proposals will often be read by tired, but well-intentioned, people who have already spent a full work day in front of a computer screen, peering through microscopes, traveling or whatever. **Make it easy for them to read.** This includes:
   - Using type of reasonable size (12 pt), spacing between paragraphs.
   - Breaking up the text into easily identified subsections ideally with specific headings for RFP requirements for which reviwers will be looking.
   - Providing visuals (charts, graphs, figures and flowcharts) which amplify or clarify (or even can take the place of) dense verbiage.
4. For some panels, and many reviewers, good summary figures help. Some panels will pull a figure out to show other panelists a summary of the proposal, so give the panel some ammunition.
5. **Read the RFP** (request for proposals) carefully, and be sure that you have addressed every issue which is mentioned, provided every piece of information for which you are asked. Make sure that all requested information/elements are clearly discussed and easily identifiable in their own sections.
6. Have a look at the **Grant Proposal Guide** at NSF (available at http://www.nsf.gov), which describes how the default proposal should be structured. Make sure that everything mentioned in the GPG appears in your proposal, unless the RFP for the specific program explicitly disallows it.
7. Consider a **non-narrative format**, particularly for proposals which will undergo panel review.
   - The first page or two of the proposal should function as an **executive summary** (really independent of the project summary, which is very brief and has specific requirements for addressing Criteria I and II, making it a poor vehicle for an in-depth summary). This is the primary place in which you must convey excitement.
   - Subsequent sections can be divided up, at least in part, according to **information requested in the RFP**. It makes it very easy to panelists if they can turn directly to a specific section titled `Evaluation' or `Management Plan' when they are checking to see if you have provided required info on the Management Plan, or if a discussion ensues about whether or not the Evaluation strategy is more appropriate than that of a different proposal.
   - Required sections that don't easily fit into a narrative body structure (results from prior support, Criterion II details, management plans) can be included without looking like afterthoughts or outliers.
8. Include a **realistic budget**. Read the Grant Policy Manual (available at http://www.nsf.gov) to see what costs are allowed; talk with faculty members in your department who have had NSF grants to get tips on what you can and can't ask for. Budgets which are out of bounds on either the high or low ends suggest that the research program has not been well thought out.
9. You need to cite **enough background literature to demonstrate that you are conversant** with the subject area, and (generally speaking) reviewers are favorably disposed toward proposals which cite their own research.

Writing Tips

1. The value of **good writing** in developing an easy-to-read, flowing, well formulated, compelling case for your work can not be understated. All this takes considerable time for most of us, even successful proposal writers.
2. Good writers invariably **rewrite**. This serves to make the style and logic consistent. Be sure to leave yourself time to rewrite before the proposal is due.
3. Find somebody who is a proficient writer to read the proposal and give comments. **Internal review** of proposal drafts from colleagues, postdocs, and even grad students can help smooth out many rough edges, gaps in logic, etc.

Evaluation and Accountability

1. There is a stong emphasis at NSF (particularly in EHR) on **evaluation components.** These include things like clearly stated theories of action which are often strengthened by detailed logic models.
2. Even for proposals with no explict EHR component, an **evaluation plan** for educational or outreach elements makes it clear that the PI is serious about completing the proposed work, learning from it and making it as good as possible for others to use.
3. Here is an NSF link that discusses aspects of unsuccessful proposals to the math/science partnership program (MSP)- a new and very large NSF education initiative:
   http://www.ehr.nsf.gov/msp/include/keyfeatures03.htm
   You will note at the bottom the importance being placed on **evidence-based outcomes** and **accountability deficiencies.**
4. There are many evaluation sites that provide support and **resources for evaluation**-related issues. Among the best is:
   http://www.wmich.edu/evalctr/ess.html
   This site offers resource links, as well as a database of evaluators with expertise in a variety of areas.

Initiatives and Multi-Disciplinary Proposals

1. Initiatives at NSF are new, large-scale scientific enterprises, often cutting across disciplines and programs. They frequently serve as 'poster children' for NSF, principal components in NSF's attempts to serve the American people and impress Congress using its secret scientific powers. Consequently, these initiatives are about **50 percent good science** and the rest is salesmanship to the legislative and executive branches, the community of science, and other funding agencies. Consequently,
   - There is no clear track record, at least in the initial stages of the initiative, of successful proposals,
   - Requirements in the RFP may be virtually independent of one another, and in some cases semi-contradictory,
   - Program officers at NSF and reviewers both are uncertain about what is really desired in a good proposal, and the expectation at NSF is for good ideas to show up which will help define the future course of the initiative.
2. Examples of recent initiatives include:

- Frontiers in Integrative Biological Research (FIBR)
- Assembling the Tree of Life
- Biocomplexity in the Environment
- Plant genome research
- Nanoscale science and engineering
- Collaborative research in Chemistry
- Physics Frontiers Centers
- Focused Research Groups (FRG) in mathematics
- Information Technology Research (ITR)
- Science and Technology Centers
- Integrative Graduate Education and Research Traineeship program (IGERT)

FIBR, for example, is for very large, basic questions. Panels will be highly diverse and successful proposals must spark interest from all around the table.

3. If you are going to attack collaborative interdisciplinary work, you have to do the groundwork. Go to the planning meetings for the big stuff; find the niche for your work, and develop it. Find the hole in the big effort that you can fill. And - look at around Utah State for collaboration. There are a vast number of things going on here, and the first place to look is close to home.
4. If you are not fully prepared, consider applying for a **Planning Grant** or a proposal for a **Research Coordination Network** (which will allow you to work out how a educationally and geographically broad group of investigators can usefully interact). Most of the initiatives support a number of grants for groups to take good ideas and make them realistic competitors for the full competition.
5. There is much less space to focus on technical disciplinary elements in multidisciplinary proposals, and panelists are less likely to have expertise in all areas tangent to the proposal. Consequently good overviews and plain, generally **accessible descriptions** become much more important. Find somebody who has been on a similar panel and ask them to give you feedback on the technical level and integration of the proposal. Contact the program officer(s) to find out what they are looking for and how they interpret the RFP. They will be providing advice to the panel.
6. Foci of the proposal must include:
    - Stressing the novelty of the enterprise and how science will be changed
    - Integration of research and education
    - Very serious integration of Criterion II issues (see above)
    - Integration of research team and the extra effectiveness granted by broadening participation
7. For big panels with many people outside your research area you want to make sure to write something that satisfies the single person in the room who actually knows what you are talking about, but will pique the interest of all the others.
8. Include a serious **evaluation plan** for the proposed effort. Think of ways to quantify and report measurable outputs, and consider including a plan for bringing in external experts periodically to give feedback and evaluate progress.
9. When multiple investigators are included it is important for the team to appear well-integrated.
    - Try to present some kind of **history of successful collaborations** among team members. Even scheduling an ongoing seminar that everybody participates in

(perhaps only monthly) is something that can mentioned and conveys the impression that the team is serious about working together (and able to!).
    - Be careful that the different components of the body do **not appear to be integrated with a stapler**. Designate somebody (competent) to read through the entire proposal and make style, verbiage, references, and grammar consistent among the various contributors.
    - Clearly indicate a **plan for continued interaction,** meeting, sharing of results.
10. Include a clear chart or figure indicating **responsibilities** of all investigators, timelines, and deliverables. The management plan is extremely important -- make it clear who has the various roles, how will it be coordinated, time table, and benchmarks for progress.

Watch for Upcoming Events

Science and Engineering Faculty Social at the Caine House (4-6:30 PM, 24 November, 2003). Come meet other scientists and engineers, as well as the VP for Research (Brent Miller) and Dennis Paffrath, director of the Sponsored Programs Office. Light refreshments and beverages 'for all tastes' will be provided.

Submission of Proposals via FastLane workshop, to be scheduled by the Sponsored Programs Office, Spring, 2004.

ADVANCE Research Brownbags, research presentations and discussions on career advancement for all faculty members, to be scheduled as part of the Supportive Workplace Initiative.

Contact Information

Anne Anderson (anderson@biology.usu.edu), a professor in Biology, does research in applied biological systems with an interest in combating plant disease and bioremediation. She has served on granting panels for NSF (program oversight for Biosciences, REU grants), USDA (panels for plant pathology and nematology and for EPSCOR), EPA (Panel for microbes in the environment) and for NASA (Extended space travel design). She is currently also working on the ADVANCE Supportive Workplace Initiative as Coordinator for Research Connectivity.

Jim Dorward (jimd@cc.usu.edu) is an Associate Professor in the Department of Elementary and Middle Level Education at Utah State University. He specializes in Program Evaluation, Research Methods, and Mathematics Education. Currently, he is Co-PI on an evaluation capacity-building project with NSF's Math, Science Partnership program and Co-PI on a National Science Digital Library (NSDL) service project. He also serves on NSDL's Evaluation and Impact Standing Committee.

Jim Powell (powell@math.usu.edu), a professor in Mathematics, specializes in the application of quantitative methods and modeling in science and engineering. He has served as a PI for six NSF grants, submitted successful proposals to DARPA, USDA Forest Service, USGS Fish and Wildlife Service, and been a co-PI for several multi-disciplinary initiatives (including FIPSE and Utah State's ADVANCE Supportive Workplace Initiative), and reviews between two and ten

NSF proposals each year from Math, Computer Science, Biology, Ecology, and International Programs.

Kim Sullivan (yejunco@biology.usu.edu) is an Associate Professor in Biology. Her research areas are animal behavior, ornithology and women in science. Kim is a co-PI on the USU Advance project funded by NSF. She served as Program Officer for the Animal Behavior Program at NSF during 2001 and 2002.

Resources on the Web

The National Science Foundation	http://www.nsf.gov
The ADVANCE at Utah State website	http://websites.usu.edu/nsf
Sponsored Programs Office at Utah State	http://www.usu.edu/vpr/funding/programs/
Evaluation Resources	http://www.wmich.edu/evalctr/ess.html
Communicating about Evaluation	http://www.ehr.nsf.gov/rec/programs/evaluation/handbook/
	http://www.fdi.vt.edu/Archive/PDFs/2002/Webinstruction/mixed_evalmanual.pdf

Acknowledgements

We would like to thank Martyn Caldwell (Director, Ecology Center), Jim Evans (Professor, Geology), and Jim MacMahon (Professor, Biology) for their comments and suggestions about earlier drafts of this document. One of the great things about Utah State is the strength of the senior scientists and their willingness to offer their expertise; thanks, gentleman, for your assistance!